Rauli Rinnekangas

Digital work productivity in Finnish organizations

Enablers and challenges according to knowledge work professionals

School of Technology
and Innovations
Master's Thesis in
Digital Business
Development

Vaasa 2022

UNIVERSITY OF VAASA
School of Technology and Innovations
Author: Rauli Rinnekangas
Title of the Thesis: Digital work productivity in Finnish organizations : Enablers and challenges according to knowledge work professionals
Degree: Master of Science in Economics and Business Administration
Programme: Digital Business Development
Supervisor: Ahm Shamsuzzoha
Year: 2022 **Pages:** 114+15

ABSTRACT:
Information technology (IT) is an integral part of organizational activities such as the production and provision of products and services as well as connecting people regardless of time and place. Digitalization of processes is often driven by the goal of improving work productivity which is a major source of economic growth, employment and well-being. Besides incremental improvements, the IT-driven development results in the transformation of work which is becoming increasingly knowledge intensive. Despite investments in IT, the productivity expectations have often been achieved with mixed results. According to previous researches, the potential causes of this productivity paradox relate to characteristics of IT, industry differences, mismeasurement and mismanagement, as well as country specifics, among others. Due to the complexity involving various potential influencing factors, the issue continues to be the basis for further research. This thesis complements the productivity research by focusing on digital work productivity from the perspective of knowledge work professionals in Finnish workplaces. Using a mixed method approach involving survey and case strategies, a questionnaire was sent to the members of the Union of Professional Engineers in Finland (Insinööriliitto IL ry) to collect data for quantitative and qualitative analysis. Over 300 responses produced a rich variety of information over the research area, which indicated that the use of IT in relation to work productivity in Finnish workplaces is perceived differently depending on the professional role (managerial or specialist), the field of workplace, the sector (private or public), the size of workplace organization (the number of employees), and domestic or foreign ownership of the organization. The results indicated that while the use of IT in work was widely acknowledged, its impact was unknown or seen as difficult to determine by many respondents, and the evaluation of the productivity impacts was often based on subjective experiences rather than tangible measurement. As an example, IT-enabled remote work was perceived as contributing to the productivity of routine work processes by enabling greater autonomy in managing personal work, which consequently improved work motivation; conversely, others perceived remote work as limiting personal interactions, which inhibits cocreational activity to generate productivity improving innovations. Regarding other challenges, digitalization was defined as increasing overlapping or incomplete IT systems and lacking end-user support, for instance, which indicated counterproductive total due to direct impacts (i.e., increased workload and -time) and their consequences (e.g., lower work motivation). The results suggest that digitalization propagates transformational effects which, depending on the implementation in work organizations, may improve work productivity or inhibit the materialization of preconditions for the improvement. For improving knowledge work with the use of IT, the thesis provides suggestions including: better alignment of remote and on-site work, increasing the inclusion of knowledge workers and the development of tangible measurement methods for the follow-up of productivity of IT.

KEYWORDS: digitalization, IT, knowledge work, work productivity, workplace

VAASAN YLIOPISTO
Tekniikan ja innovaatiojohtamisen akateeminen yksikkö
Tekijä: Rauli Rinnekangas
Tutkielman nimi: Digital work productivity in Finnish organizations : Enablers and challenges according to knowledge work professionals
Tutkinto: Kauppatieteiden maisteri
Oppiaine: Digitaalinen liiketoiminnan kehittäminen
Työn valvoja: Ahm Shamsuzzoha
Valmistumisvuosi: 2022 **Sivumäärä:** 114+15

TIIVISTELMÄ:
Tietotekniikka (IT) on olennainen osa organisaatioiden toimintoja esimerkiksi tuotteiden ja palvelujen tuottamiseksi ja välittämiseksi sekä yhteydenpidossa ajasta ja paikasta riippumatta. Prosessien digitalisoinnilla tavoitellaan usein työn tuottavuuden kohentamista johtuen tuottavuuden merkityksestä talouskasvun, työllisyyden ja hyvinvoinnin kannalta. Inkrementaalisten parannusten ohella IT-painotteinen kehitys muuttaa osaltaan työn luonnetta tietotyökeskeiseksi. IT-investoinneista huolimatta tuottavuusodotukset ovat usein toteutuneet vaihtelevin tuloksin. Aiemmat tutkimukset ovat todenneet, että tämän tuottavuusparadoksin potentiaaliset syyt liittyvät muiden muassa IT:n ominaispiirteisiin, toimialojen eroihin, mittauksen ja johtamisen haasteisiin, sekä maakohtaisiin tekijöihin. Erilaisten vaikuttavien tekijöiden aiheuttaman monimutkaisuuden johdosta ilmiö on edelleen lisätutkimuksien kohteena. Tämä päättötyö täydentää tuottavuustutkimusalaa tarkastelemalla digitaalisen työn tuottavuutta suomalaisilla työpaikoilla työskentelevien tietotyöläisten näkökulmasta. Tutkimusotteena käytettiin monimenetelmätutkimusta kysely- ja tapaustutkimusstrategioihin perustuen, ja tutkimuksen kohderyhmänä olleille Insinööriliitto IL ry:n jäsenille lähetettiin kysely datan keräämiseksi kvantitatiivista ja kvalitatiivista analysointia varten. Yli 300 vastausta tuottivat monipuolista tietoa tutkimusalueesta, osoittaen että IT:n käyttö suhteessa työn tuottavuuteen mielletään suomalaisilla työpaikoilla eri tavoin riippuen työroolista (johto- tai asiantuntijataso), toimialasta ja sektorista (yksityinen tai julkinen), työorganisaation koosta (työntekijöiden lukumäärä), sekä organisaation omistajuudesta (ulkomainen tai kotimainen). Tulokset osoittivat, että vaikka IT:n työkäyttö tunnistettiin laajalti, useiden vastaajien mukaan sen vaikutusta ei tunnistettu tai vaikutusarviointia pidettiin vaikeana, ja tuottavuusvaikutusten arviointi perustui usein subjektiivisiin kokemuksiin mittausmenetelmien sijaan. Esimerkiksi IT:n mahdollistama etätyö miellettiin kohentavan rutiininomaisten työprosessien tuottavuutta suuremman autonomian myötä oman työn johtamiseksi, minkä tuloksena työmotivaatio kasvoi; päinvastaisten näkemysten mukaan etätyö haittaa henkilötason vuorovaikutusta, rajoittaen siten yhteisluonnin aktiviteetteja uusien tuottavuutta kohentavien innovaatioiden kehittämiseksi. Lisäksi digitalisaation haasteina mainittiin esimerkiksi päällekkäiset tai keskeneräiset IT-järjestelmät ja käyttäjätuen puuttuminen, joiden lopputuloksena oli negatiivinen kokonaistuottavuus suorien syiden (työmäärän sekä ajankäytön kasvu) sekä syiden seurauksien (heikentynyt työmotivaatio) johdosta. Tuloksien valossa digitalisaatio lisää muutosvaikutuksia, jotka työorganisaatioissa tapahtuvasta toteutuksesta riippuen voivat kohentaa työn tuottavuutta tai estää kohennuksen edellytysten materialisoitumista. IT:n käyttöön perustuvan tietotyön kehittämiseksi tämä päättötyö ehdottaa: etä- ja läsnätyön linjakkaampaa yhteensovittamista, tietotyöläisten osallistamisen lisäämistä sekä konkreettisten mittausmenetelmien kehittämistä IT:n tuottavuuden seurantaan.

AVAINSANAT: digitalisaatio, tietotekniikka, tietotyö, työn tuottavuus, työpaikka

Contents

Figures

Tables

Abbreviations

AI	Artificial Intelligence
GPT	General-Purpose Technology
ICT	Information and Communication Technology
IL	Insinööriliitto IL ry, the Union of Professional Engineers in Finland
IT	Information Technology

1 Introduction

This thesis focuses on studying digital work productivity in Finnish workplaces from the perspective of their members who use information technology (IT) in work as knowledge work professionals. As an organizational goal, productivity depends on combining financial, material, technological, and human resources in production processes. Improved productivity stands for material prosperity, which is the basis of goals such as economic growth, employment, and overall well-being. For these purposes, leveraging technology in productivity has been recognized important in modern economies and it has been one of the key drivers in the digitalization of organizations during past decades (CORE, 2022; Edquist & Henrekson, 2006; Pohjola, 2020; Schweikl & Obermaier, 2020). Despite investments in IT, researchers have concluded that digital productivity expectations have often been achieved with mixed results. For instance, productivity growth in Finland has been lagging during the past decades despite the high and continuous adoption of IT in Finland (Ailisto et al., 2021a; Bank of Finland, 2018; Finnish Productivity Board, 2020; Pohjola, 2020; Stenborg et al., 2021). According to previous researches, the potential causes of this productivity paradox relate to characteristics of IT, industry differences, mismeasurement and mismanagement, as well as country specifics, among others. Due to the complexity involving various potential influencing factors, the issue continues to be the basis for further research. (Ailisto et al., 2021a; Dreyfuss et al., 2008; Schweikl & Obermaier, 2020; Syverson, 2011; van Ark, 2016.)

Leveraging IT in work productivity requires the involvement of skilled people in designing, implementing, managing, and working in related processes and tasks. The role of appropriate skills is particularly important since the introduction and use of IT entail the transformation of work due to the increased use of intangibles such as data, information, and their combinations turned into knowledge. Moreover, improving work productivity through knowledge-based work requires continuous competence development by the members of organizations. (Castrén et al., 2013; Gupta, 2022; Muzam, 2022; Shujahat et al., 2019; Vuori et al., 2019; Vähämäki et al., 2019.) Consequently, understanding the

relation of the elements of digital work productivity, i.e., IT and professionals using IT in the knowledge-oriented work, depends also on insights which the members of organizations provide for analysis. These insights can relate to the enablers and challenges which exist in the work, which in turn offers avenues for further analysis on their influence behind of the productivity paradox.

Therefore, research on dynamics of IT and knowledge work professionals in workplaces is the primary study area of interest in this thesis which structure is as follows: first, the objectives and research motivation is introduced in chapter 1. Chapter 2 covers literature review on work productivity and productivity paradox, and nature of transformation of work to IT-based knowledge work. In chapter 3, research design using mixed method approach involving survey-based research strategy for gathering and analysis of primary data is introduced. In chapter 4, results of the primary data is analysed using the introduced mixed method approach. Chapter 5 covers discussion with conclusions including outlining limitations and discussing future research directions.

1.1 Research objective

The research objective was to study digital work productivity in Finnish workplace organizations by reflecting how the relation of IT and work productivity is perceived by their members as knowledge work professionals. The backgrounds and experiences related to the use of IT in work differ, which in turn has impact on work productivity, among others. Consequently, research questions related to the research objective are as follows:

1) What impacts in the use of IT in Finnish workplaces have been identified by knowledge work professionals?

2) How is the relation between work productivity and the use of IT understood or perceived by knowledge work professionals?

The answers to the previous questions contribute to the main interest as represented by the follow-up question:

3) What IT-related enablers and challenges can be identified as impacting directly or indirectly on work productivity in Finnish workplace organizations (of knowledge work professionals), which in turn could elaborate the potential causes behind of the phenomenon of productivity paradox?

The answers to the first research question introduce perceptions on the impacts of IT in work, which facilitates understanding digitalization-related experiences in Finnish workplaces. The answers to the second question cover the relation of work productivity and IT according to knowledge work professionals. In order to answer the third and most central question, the resulting information is used in analysing the potential causes of the productivity paradox in the Finnish workplaces.

1.2 Research structure

The defined questions guide the objective of the research which proceeds as follows: first, literature review is introduced to provide the theoretical basis on productivity, digitalization, the phenomenon of productivity paradox, and the use of IT in knowledge-based work. Second, empirical part is carried out involving the results of the conducted survey among knowledge work professionals as represented by the members of Union of Professional Engineers in Finland (Insinööriliitto IL ry in Finnish). Addressing the defined interest of information by using primary data gathered from the IL members was based on the rationale of acquiring information from the group of people whose work is extensively based on use and application of knowledge, and who have experience on using IT in their professional roles and in work. The IL members work in different industries in various technical, engineering and design roles where IT is used in daily work which can be defined as involving knowledge-based work in several respects. The use of IT in knowledge-based work by the IL members presents opportunity to clarify factors in digital work productivity from unique perspectives.

1.3 Research contribution

This research contributes in three ways: first, focusing research on the specific group of knowledge work professionals contributes with insights on the enablers and challenges of digital work productivity and their implications for the productivity paradox from unique perspective**.** Second, since the primary data is acquired by carrying out a survey involving Finnish knowledge work professionals, the insights contribute with understanding about country-specific implications for digital work productivity. Third, the previous two outcomes complement previous research on the digitalization of knowledge work by clarifying factors impacting on the productivity. Finally, the topicality of the research is augmented with information on the impact of COVID-19 pandemic on digitalization, knowledge work and its productivity.

2 Literature review

The literature review is carried out as follows: first, conceptual basis is introduced involving key definitions, followed by defining their relation in respect to the issue in digital work productivity known as productivity paradox. After the general definitions, a country-specific perspective on productivity paradox in Finland based on existing research is outlined to focus research scope of this thesis. Furthermore, due to the focus on digitalization related productivity in workplaces, previously carried out research is introduced to provide contextual dimensions for later, empirical part of the research. The chapter concludes with topical information on the impact of COVID-19 pandemic on digitalization, work and its productivity.

2.1 Definitions

In this section, key definition used in the research are defined. They provide conceptual descriptions of the topics which relations are covered later in the thesis.

2.1.1 Organization

Organizations of different type and size can be described universally: an organization is a unit of formal positions, usually held by individuals, with explicit objectives, tasks, processes and resources (for example people, buildings and machines). The leading principle of an organization is its goals. The goals can be commercial (profit, customer satisfaction, continuity), social (governing society, providing collective services), or idealistic (political, cultural or religious organizations). Organizational strategy defines how an organization is to use the resources to achieve prioritized goals as efficiently as possible. To reach the goals, the tasks and processes that have to be performed by its individual members by using dedicated tools and methods. (Bouwman et al., 2005, p. 40-42.)

Organizational goals may require transformation of an organization or parts of it. Organizational transformations are strategic enterprises which involve people, processes, and

culture (David & Wright, 1999; Tardieu et al., 2020). For instance, enhancing processes with technological innovations depends on end-users with skills and knowledge to leverage the technology in the processes and to attain expected goals as the result of the introduced improvement. Also, the development of organizational innovation as systems which permit organizations to use new technology efficiently is often required (Edquist & Henrekson, 2006, p. 34). In case of large scale transformations, the holistic development approach is essential as changing established cultural norms is a huge task, and concurrent operation of dual cultures during transformation can be divisive and obstructive. If only parts of the transformation are pursued without considering other organizational factors, it stands for lack of coherent strategy and hence the absence of an effective transformation plan, which will likely result in transformation failure. (Tardieu et al., 2020.)

Organizational transformations can be facilitated by leveraging the disciplines and perspectives of organization theory, a multidisciplinary body of scholarly work, which offers means to address different organizational areas. The disciplines facilitate understanding on how organizations work, why they come to be structured in particular ways, and why some organizations are more successful than others. They are used in determining why some organizational areas do not function as expected so they can be developed further. (Foster, 2022.) Modern disciplines date back to the 19th century when executives and consultants in industrial organizations needed to design and manage production processes to improve their productivity, while economists and sociologists focused on changing organizations within industrializing societies. Accordingly, most of the disciplines relate to sociology, business management, and economics. (Hatch, 2018, p. 19.)

2.1.2 Productivity

As a core concept in economics, productivity describes the efficiency of production, i.e., production of (greater amount) of outputs with (less/certain amount of) input. It originates from agriculture where it was used in determining the amount of harvest from a land area (Uusi-Rauva, 1997). The modern meaning of the term originates from the

Second Industrial Revolution in the 19th century in the United States, where industrial organizations had a challenge in form of unskilled labour. Frederick Taylor introduced Scientific Management, a set of practices for organizing work processes, which increased work efficiency and production output. Since then, organizations have focused on productivity as a key performance metric. Productivity is also viewed on national, international, and industry levels based on the interest of economists, engineers, and politicians, for instance. (Buchanan & Huczynski, 2019, p. 456; Drucker, 1999, p. 80-81; Rantanen, 2005, p. 5, 9-11.)

Productivity can be defined as follows: “Inputs of labour (human resources), capital (physical and financial capital assets), energy, materials, and data are brought into a system … (which) … are transformed into outputs (goods and services). Productivity is the relationship of amount produced … during a given period of time and quantity of resources consumed to create or produce outputs over the same period of time." (Sink 1985, cited in Rantanen, 2005, p. 7). Single factor (e.g. labour) productivity is defined by division of output with input, while multi-factor productivity is more common (see Figure 1). (Brynjolfsson, 1993, cited in Macdonald et al., 2000, p. 602; OECD, 2022.) Traditionally, productivity is measured in physical or monetary terms (Harris, 1994, p. 13). Determining productivity with advanced quantitative methods has been covered in detail by Schweikl & Obermaier (2020).

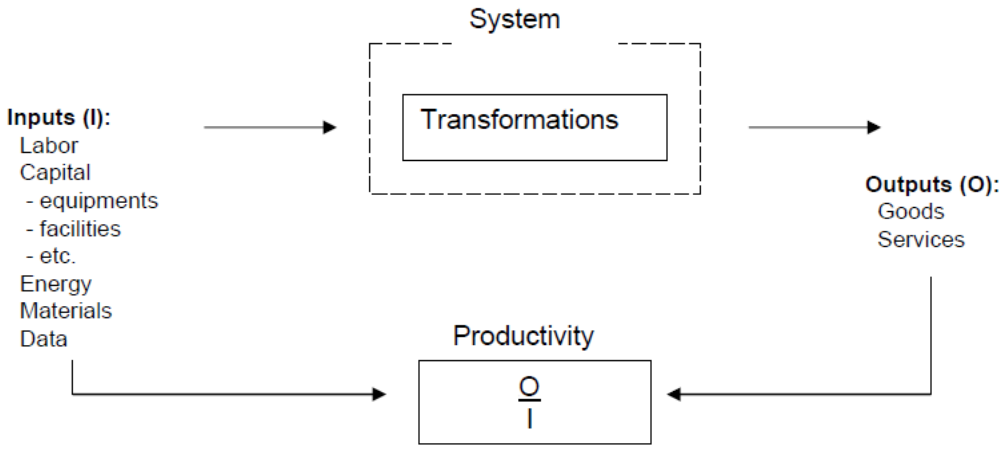

Figure 1. The concept of multi-factor productivity (Sink, 1985, as cited in Rantanen, 2005).

The focal question is: How can productivity of X (e.g. individual, group, or organization) be increased? An answer is increasing output for the same input or reducing input for the same output. (Harris, 1994, p. 3, 59.) Also, productivity improves by introducing better technology and practices in production, and when capital and labour are allocated from lower to higher productivity work (Finnish Productivity Board, 2020, p. 21). Besides tangible inputs like labour and capital goods, multi-factor productivity depends on the effects of changes in management practices or organizational areas, brands, knowledge, network effects, adjustment costs, the economies of scale, the effects of imperfect competition and measurement errors, among others: these factors determine the residual part of productivity growth which cannot be attributed to labour and capital inputs (OECD, 2022; Syverson, 2011). Accordingly, labour productivity growth is caused by three factors: growth in capital intensity (capital per working hour), change in quality of labour input, and total factor productivity which covers the part which the changes of the other two factors cannot explain (Stenborg et al., 2021, p. 12). Due to shift from manufacturing products to information-based services and offerings, the importance of intangibles in production has increased, challenging traditional productivity approaches.

2.1.3 Digitalization

Digitalization is the transformation of society and economy from an industrial age of analogue technologies to an era of knowledge and creativity based on digital technologies

and innovation (Innolytics, 2020). It has involved the development and diffusion of information and communication technologies (ICTs), also known as digital technologies, over decades (see Table 1). In the late 20th century, computer processing, faster data transfer, and expanding Internet connectivity combined with software, which enabled the digitization of many physical, non-digital items effectively and in large scale.

Table 1. Timeline of the IT revolution (Bodrožić & Adler, 2022).

Critical problems in the evolution of the digital paradigm	Period	Major shift	Founding of exemplary organizations
Development of core ICT foundations	1960s	Incubation of computer components	1968: Intel
	1970s	Rapid rise of mainframe computers	1975: Microsoft
			1976: Apple
			1977: Oracle
	1980s	Rapid rise of personal computers	1982: Adobe
			1984: Dell
			1985: Cisco
			1987: McAfee, Huawei
	1990s	Emergence of networked computers and Internet	1993: Nvidia
			1994: Amazon, Yahoo
			1996: eBay
			1998: Google, PayPal, Tencent
			1999: Napster, Alibaba
Development of digital technologies that facilitate a wider variety of applications	2000s	Emergence of mobile, social, platform, and cloud technologies	2001: Wikipedia
			2003: MySpace
			2004: Facebook
			2005: YouTube
			2006: Twitter, Spotify
			2008: Airbnb
			2009: Uber, WhatsApp, Pinterest, Bitcoin
	2010s	Emergence of AI, big data, Internet of Things, blockchain	2010: Instagram, DeepMind
			2011: Banjo, Snapchat
			2012: ThoughtSpot
			2013: Databricks
			2014: SenseTime, Zoox
			2015: Ethereum
			2015: CloudMinds, OpenAI
			2016: Argo AI, Clarivate Analytics

In the early 2000s, digitalization turned into buzzword due to the introduction of mobile Internet, big data, cloud computing, artificial intelligence (AI), and Internet of Things (IoT), among others, which became part of integrated solutions (Innolytics, 2020). Terms of digitization, digitalization, and digital transformation are related as shown on Figure 2: digitization refers to creating a digital representation of physical objects or attributes, such as scanning a paper document and storing it as a digital document (e.g., PDF). Digitalization refers to enabling or improving processes by leveraging digital technologies and digitized data, for example, with the introduction of automated shutdown logic of

an existing system. Digital transformation is about the holistic change of business processes as enabled or forced by digitalization technologies, for example, by shifting from local process control to the remote monitoring and control of the processes. (Gupta, 2022.) As a final outcome, digitalization results in transformation of doing things in work and other activities. In this thesis, the definition of information technology (IT) is used, since it is commonly applied as a generic umbrella term, and since it grasps the essence involving highlighted the importance of information in the transformation. Also, the plural form of information technologies (ITs) refers to different forms of IT, for instance, as shown on Figure 1 under the major shift title.

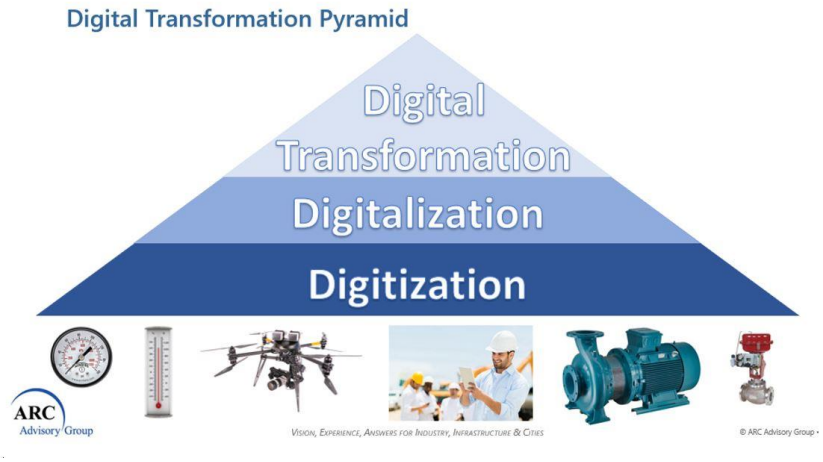

Figure 2. The concept levels of digital transformation pyramid (Gupta, 2020).

ITs have been described as General Purpose Technologies (GPTs) which are characterized by enabling wide improvement, broad applicability and usefulness in products and processes, and complementarities with existing or new technologies (David & Wright, 1999). To keep up with mainstream, ITs are adopted by organizations from the pre-digital era, which changes culture, practices, and expectations. Digital GPTs are also expected to improve productivity: in manufacturing, previous industrial revolution paradigms predate the evolutionary shift to the Digital or Fourth Industrial Revolution (Industry 4.0) (see Figure 3). In the early 19th century, the First Revolution introduced work mechanization. In the late 19th century, the Second Revolution continued industrialisation with new technologies and more efficient work organization, and the Third Revolution since the

1970s started digitalization and IT-based knowledge work as computers emerged to workplaces. (FITech, 2022.)

Figure 3. The Industrial Revolutions from the 18th century to the 21st century (Schwab, 2022).

The Industry 4.0 involves advanced cyber-physical systems with the interconnectivity and convergence of devices and systems in digital, biological, and physical domains (Schwab, 2022). Moreover, digital GPTs are expected to enable offering diversification to compete through services, i.e. servitization of the businesses (Baines & Lightfoot, 2013, p. 61). According to Schweikl & Obermaier (2020), the implications of IT as capital part of labour productivity have been founded to enable quality improvements of output and reduction of labour costs in input. In non-manufacturing industries, ITs automate processes such as bookkeeping, and facilitate information flow with the reduced cost of coordination (Gurbaxani and Whang 1991, cited in Schweikl & Obermaier, 2020). This change is expected to produce improvements of processes together with radical transformation impacts across organizational processes and structures (Schweikl & Obermaier, 2020). Davis and Meyer (1998) described the transformational impacts as "blur" of activities, which combines interconnectivity and borderlessness, accelerated reaction time, and intangibles of products and services including intellectual and emotional activities by the end-users: this results in blurring boundaries as products become software-intensive with service aspects, while services will be standardized and modularized like

products (Davis & Meyer, 1998, p. 22). Also, digitalization enables much more which may not be achievable due to the limitations of the human factor (i.e. labour) in work processes. Accordingly, digitalization in organizations needs to be adequately managed: for instance, changing cultural norms is a huge task, and operation of dual cultures can be divisive and obstructive. If only parts of transformation are pursued without considering other organizational factors, it stands for lack of coherent strategy and hence the absence of an effective plan, which will likely result in transformation failure. (Tardieu et al., 2020.)

2.1.4 Knowledge

Knowledge can be defined as follows: while data is the basis of information, knowledge includes information as "a mix of experience, values, contextual information, and expert insights, that provides a framework for evaluating and incorporating new experiences and information. It originates in and is applied in the minds of knowers" (Davenport and Prusak, 1998, p. 5). When information as the "flow of messages" interacts with the beliefs and commitments of its holders, the process results in the creation of knowledge. These definitions underline the nature of knowledge as human-originated and -processed outcome and its foundational importance for innovations which, for instance, enable gaining competitive advantage in a marketplace. (Nonaka & Takeuchi, 1995, p. 58-59, 110.) Achieving such goals may be challenging, since human-held knowledge is often fuzzy, which requires efforts to define, measure and manage it (Ipe, 2003, p. 339).

ITs provide means and capacity for creating, gaining, and organizing knowledge, which in turn increases operational effectiveness and competitiveness, for instance (Adamczewski, 2016). As a result, the increasing use of ITs transforms activities to become more data-, information-, and knowledge-based than before: hence, digitalization is a holistic transformation process which in organizational level should involve people, processes, and culture (David & Wright, 1999; Tardieu et al., 2020). Enhancing processes with technological innovations requires having other organizational factors in place first: above all, the end-users need to have appropriate skills and knowledge before attaining

goals by leveraging technology is feasible. Also, work needs to be reorganized by developing organizational innovations i.e. systems and practices which permit organizations to use new technology efficiently (Edquist & Henrekson, 2006, p. 34). As a precondition, these areas require knowledge on making the appropriate organizational arrangements and as a key enabler in the introduction and use of IT in organizations.

2.2 Productivity paradox

In this chapter, the issue of productivity paradox is introduced: first, the background and potential causes as outlined by previous researches is introduced. After that, the issue in case of Finland is addressed.

2.2.1 Background

Starting in the late 1960s, the research spans decades following the emergence and diffusion of ITs at the increasing rate, particularly in developed countries. The productivity paradox is based on research conclusions that investments in ITs have not resulted in expected productivity growth, which contradicts the presumptions of the previous Industrial Revolutions about the importance of technological innovations in maintaining economic growth (CORE, 2022; Edquist & Henrekson, 2006). The principle of technology-driven productivity growth was unchallenged until the productivity slowdown emerged in the early 1970s till the 1980s in spite of large absolute investment increases in research and development, scientific knowledge and technological innovations, which suggested the existence of the paradox (Diewert and Fox, 1997, cited in Macdonald et al., 2000, p. 602). Solow summarized the paradox in 1987: “we see transformative new technologies everywhere but in the productivity statistics” (Solow 1987, cited in Agrawal et al., 2019, p. 24). History of the paradox with coinciding developments in economy and IT from the 1970s up till the 1990s have been addressed in detail by Macdonald et al. (2000) and Dreyfuss et al. (2008).

When productivity increases emerged in the 1990s and the early 2000s, the paradox seemed as overcome; however, this has been contested (Schallmo & Tidd, 2021, p. 146). According to van Bark (2016), increased spending on ITs such as mobile technology, Internet, and cloud has not generated visible improvement in productivity despite declining IT prices, shifting from internal investments to external IT services, and continued increase in knowledge assets to support IT. Similar results were found by Gebauer et al. (2020) in companies struggling to earn revenue growth in return of IT investments. Schweikl & Obermaier (2020) concluded that while the studies from the late 1980s through 2006 indicated the positive relationship between IT investments and productivity, the results are still mixed: moreover, ITs of the Fourth Industrial Revolution such as IoT, AI or blockchain seem to have failed to live up to the expectations on improved productivity so far. The lack of productivity of ITs has been recognized by platforms such as OECD (Pisu et al., 2021). The key question continues to be valid: “Why have the enormous investments in IT not resulted in clear-cut increases in organizational productivity?“ (Harris, 1994, p. 3).

2.2.2 Potential causes

Due to the complexity of the issue, the causes may be due to digitalization-originated correlation or contextual differences like size and type of organizations and industry specifics (Harris, 1994, p. 292, 295). Digitalization impacts with the transformation of organizational processes and structures, which organizational complexity challenges further. Drawing from previous research in the span of three decades, Schweikl & Obermaier (2020) classified the causes as adjustment delays, measurement issues, exaggerated expectations, and mismanagement. Adjustment delays relate to IT inhibit the materialization of improved productivity which may appear later than expected, if at all. Relevant skills are required to use IT effectively, research and development of IT innovation is needed before better products, services or processes can be produced, and organizational arrangements have to be implemented as part of successful digital transformation. According to this view, the productivity impacts of IT emerge with delay, and the impact would be contingent with complementary changes in organizational practices as well as

possessing the skills as IT investments alone do not guarantee productivity growth. (Schweikl & Obermaier, 2020; Tuomi, 2004.) Also, labour market and education system follow technological evolution with delay, which slows down the process (Schweikl & Obermaier, 2020).

Measuring productivity is challenging since assessing input, output or both is difficult: usually IT investments consist of hardware and software expenses as well as support and complementary organizational expenses like training and process redesigning, which makes comparison between organizations challenging. Also, lack of IT investment data makes evaluations prone to errors. (Schweikl & Obermaier, 2020.) Intangible IT investments are often treated as current costs, which reduces added value and growth rate (Edquist & Henrekson, 2006). Also, IT evolution has been suggested as being faster than previous technological breakthroughs. As a result, quantity and quality cannot be determined easily: the price estimation of IT inputs is complicated due to fast technological change and intangible characteristics which value cannot be easily quantified. (Brynjolfsson, 1992; Edquist & Henrekson, 2006, p. 1, 32.) The issue relates also to intangible services which growing proportion in outputs is facilitated by ITs: besides multi-factor challenge involving intangible software-based ITs, the manufacturing-originated concepts and measurements of productivity are not directly applicable in services. In case of new products and services, lack of preceding items for comparison is another issue. (Macdonald et al., 2000, p. 602, 604; Schweikl & Obermaier, 2020.)

Exaggerated expectations relate to the comparison of ITs with the innovations of previous Industrial Revolutions. ITs as GPTs may not be as revolutionary, but rather being incrementally complementary and with limited real value added: instead of improving core functionality or introducing new ones, ITs may facilitate the creation of options of marginal benefit to users. Other expectations relate to gaining early benefits with significant outputs, while in reality adjustment delays may shift their materialization later and more steadily across longer time period. Moreover, the intangible nature of IT and lack of preceding reference points inhibit quantitative evaluation: as a result, intangible benefits

may get exaggerated to justify over-investments without the proper evaluation of costs and benefits. (Edquist & Henrekson, 2006; Schweikl & Obermaier, 2020.)

Mismanagement of IT relates to the inadequate implementation and utilization of presumably potent technologies. IT hype or fears of missing out of leverage potential for organizational strategy may lead to technology-focused overshooting cycle instead of holistic transformation involving complementary factors like the organizational structures and skills of the people who are expected to use IT. A challenge relates to ability to combine IT with other inputs to produce highly valued outputs: focusing on new technologies only results in lower production cost competition since diffusion of ITs as GPTs across competition reduces their leverage in differentiation. More generally, this issue relates to inability to implement digitalization strategies and business models. (Schweikl & Obermaier, 2020.)

Complementing previous definitions, the relation of IT investments and productivity is aptly described in Figure 4. Above all, unique organizational characteristics make universally applicable definitions of complementary factors improbable. Also, existing IT resources, environmental factors or even type of IT investment can cause varying productivity effects of IT investments. (Schweikl & Obermaier, 2020.) These unique factors stand for that while the potential causes of productivity paradox have been acknowledged, their priority and impact as more or less linear cause and effect phenomenon has not been or cannot be recognized as universally applicable. The issue is acknowledged by traditional economic research, but it cannot pinpoint its origins due to the inherent complexity involving multiple, interrelated and mutually contributing factors.

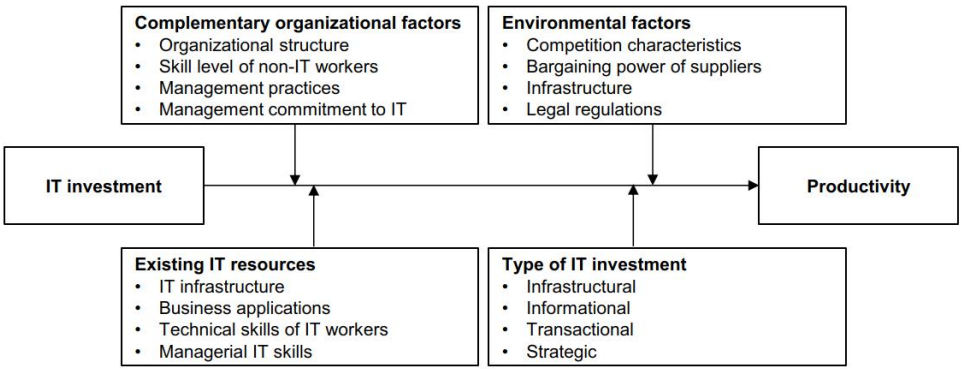

Figure 4. The factors influencing IT investments and productivity (Melville et al. , 2004 and Aral and Weill, 2007, as cited in Schweikl & Obermaier, 2020).

2.2.3 Productivity paradox in Finland

Research have acknowledged the paradox in Finnish sectors, industries, and organizations. In Finland, ITs are recognized as important producers of economic wealth and in maintaining well-being by improving productivity (Castrén et al., 2013; Finnish Productivity Board, 2020; Parviainen et al., 2017; Pohjola, 2020; Stenborg et al., 2021). The private sector has been major contributor in productivity with its share of the Finnish gross domestic product (consisting of added value by products and services) being around 80 % in comparison with 20 % by the public sector (Bruun, 2014), and with 56 % of the employed people (Clausnitzer, 2022). Also, the share of total research and development expenses by the private sector is around two-thirds (Valtioneuvosto, 2021, p. 15). Public sector productivity has been difficult to determine due to country-specific differences and indirect impacts on production, which makes the measurement and evaluation challenging (Castrén et al., 2013, p. 21; Savela, 2010, p. 2; Stenborg et al., 2021, p. 11). Parviainen et al. (2017) have approached IT-based productivity from the perspective of less work effort/input in production of public services and introduction of measurement methods in the public sector: the focus is on the acknowledged drop in productivity in public sector services, which existence has been reported by André & Chalaux (2016), for instance. Due to better comparability and the sector importance, private sector perspective was selected to examine the productivity paradox in Finland based on existing research.

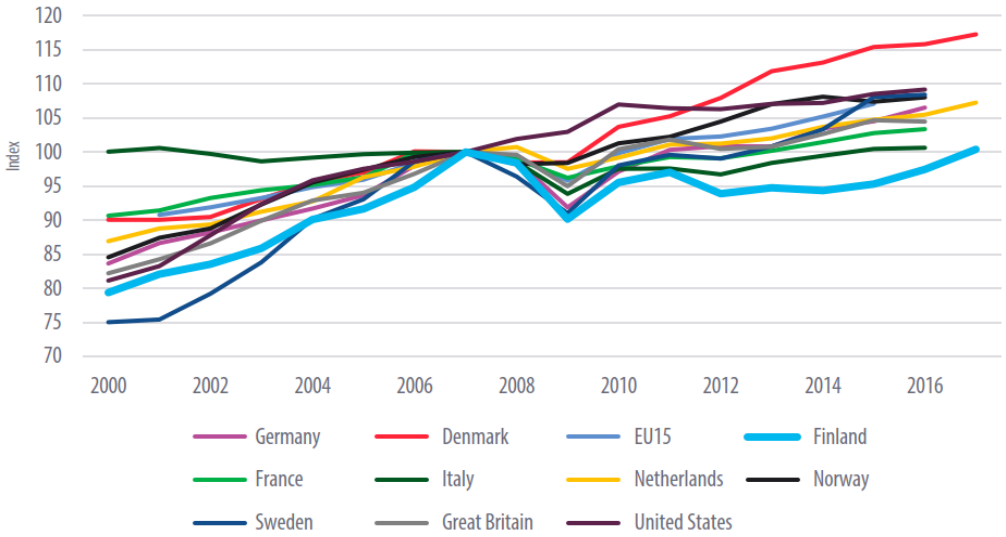

Figure 5. The labour productivity of private sectors in Finland and competitor countries (Finnish Productivity Board, 2020, p. 34).

Work productivity and total factor productivity in the private sector declined due to the financial crisis of 2008 and the collapse of Finnish electronics industry in the early 2010s, and the recovery has been slow as shown on Figure 5 (André & Chalaux, 2016, p. 9; Bank of Finland, 2018; Finnish Productivity Board, 2020, p. 58-59, 67-68; Pohjola, 2020, p. 32, 34-35, 58; Stenborg et al., 2021). While the importance of ITs to improve productivity has been recognized, the results have been limited or even opposite as shown on Figure 6: according to corporate data on output and input figures in the same units, labour productivity in digital services has sunk in absolute and relative terms (Stenborg et al., 2021, p. 39). While the share of IT capital in the cumulative growth of the productivity has been greater over other capitals, country specifics stand out: during 2010-2018, the share was around 5 % in Finland, whereas in Sweden and the United States the share grew from 10 % to 13 % and 7 % to over 10 %, respectively. Together with increasing IT capital, labour productivity in the competitor countries has improved with the growth of over 35 %, while in Finland the growth has turned below of 35 %. (Pohjola, 2020, p. 29-30.) As a summary, the research snapshots indicate about the existence of productivity paradox with Finnish characteristics, i.e. inefficiencies in the Finnish IT industry and digitalization of organizations.

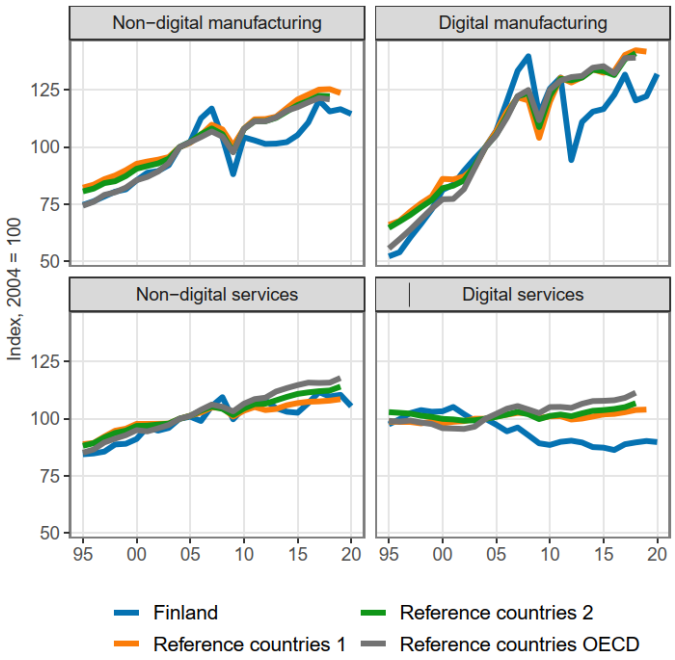

Figure 6. The labour productivity in selected sectors, index 2004 = 100. Reference countries 1: France, Belgium, Austria, Italy, Netherlands. Reference countries 2: Sweden, Norway, France, Belgium, Austria, Italy, Netherlands, Germany, Spain, Portugal. Reference countries OECD: Sweden, Norway, France, Belgium, Portugal. (Stenborg et al., 2021, p. 39.)

The potential causes of productivity paradox have been noted in Finland as well: for instance, the introduction of IT in Finnish healthcare has been recognized to involve the elements of adjustment delays, exaggerated expectations, and mismanagement. Limited investments in skills development combined with IT issues (multiple systems, system downtime, lack of vacant computers) and shifting non-core tasks to nurses as IT-automated work have generated challenges in the field where productivity is based on provision of (non-IT based) services on site. (Castrén et al., 2013, p. 104, 106, 124.) The lack of Finnish IT capital investments may be due to lack of competition in product or (non-IT) production factor markets, which does not encourage leveraging technological opportunities or innovation for competitive advantage (Pohjola, 2020, p. 51-54; Stenborg et al., 2021, p. 55). Information, communication, and financial industries have been recognized as digital pioneers due to global competition, whereas local industries like construction and machinery manufacturing have lacked similar pressures and incentives in introduction of and innovation with ITs (Ailisto et al., 2021b). Also, input reallocation on industry level has had negative effect on the productivity growth of IT industry in Finland

during 2000-2018, which could be due to the growing number of unproductive IT firms which are investing and hiring in order to become productive in future (Fornaro et al., 2021, p. 10, 37). This view follows the traditional dynamics of economics: investments need to be made to start economic activity (e.g., production), which shows up negatively in the figures as positive outcomes are expected to follow later. Castrén et al. (2013) concluded similarly on IT-based service sector development. Also, the increasing complexity of operational environment (i.e. similar to environmental and complementary organizational factors in Figure 4) necessitates additional investments in non-core functions like communications and legal: i.e., while the benefits of ITs may materialize, the costs of the support functions may have negative effect on the total productivity (Ailisto et al., 2021a).

2.2.4 Limitations of economic analysis on productivity paradox

As summarized previously, different researchers have concluded the existence of the productivity paradox with potential causes, but they have not been conclusive. The issue persists in the service sector in particular, where the productivity growth has been sluggish and plummeted in case of Finland (Stenborg et al., 2021, p. 39). The continuous unproductiveness of ITs suggests that impacting factors are in-depth and complex, which traditional research approaches can determine up to a point only: as Tuomi (2004) has pointed out, IT productivity studies have been problematic since traditional economic measures miss essential parts of output in knowledge-based economies, which relates to the productivity measurement of inputs and outputs in ways that are conceptually and empirically problematic.

Consequently, complementary analysis on the potentially impacting factors of the paradox is needed by focusing on different contexts, scope and level of productivity, as suggested by Castrén et al. (2013) on involving micro-level inspection of organizations and their units and processes (Castrén et al., 2013, p. 23-24). Moreover, such complementary approaches are at the core of the fact that labour productivity by an individual is the basic unit which other productivity measurements are based on, and the analysis-based

development of this unit with changes in work conditions and practices improving productivity have been at the crux of the philosophy since the beginning. Also, since digitalization stands for the transformation of organization with people part of it, the impact on labour productivity unit level requires such level of granularity in analysis. As Pohjola (2020) has outlined, intangible ITs depend on knowledge-intensive skills in digitalized work processes as well as in innovating new products and services to improve productivity. Since the labour input factor is in essence about human element, digital transformation has implications beyond of acquiring and applying IT skills in work including individual perceptions, appreciations, and other forms of subjective understanding on the use of IT in work. In turn, these findings may produce leads on the causes behind of the phenomenon of productivity paradox in specific workplaces, and in manner which quantitative measurements and analysis cannot grasp: such workplace analyses contribute with insights on the increasing role of knowledge in work, the use of IT as part of it, and their implications for productivity.

2.3 Productivity of knowledge work

Approaches to improving productivity by work optimization originate from Taylor's Scientific Management of the late 19th century (Drucker, 1999; Kummerow & Kirby, 2013, p. 8-9). As work has evolved from physical manufacturing into increasingly intangible and knowledge-intensive involving the use of IT, the need for an up-to-date understanding about work optimization essentials has been acknowledged. This section introduces work organization approaches in respect to work evolution and recent findings on IT- and knowledge-based work in respect to related work productivity.

2.3.1 From Taylor's manual worker to Drucker's knowledge worker

Taylor's Scientific Management has been attributed to increasing manufacturing productivity on which rest the economic and social gains of the 20th century (Drucker, 1999, p. 80-82). The achievement resulted from the predictability of job performance by work task standardization and division, worker training and hierarchical management.

Experimentations with task elements (tools, materials, worker qualities) were done and measured to optimize the task productivity, and managers refined and organized the tasks for workers who were in turn presumed to be motivated by financial incentives. (Buchanan & Huczynski, 2019, p. 456-459.) In essence, Taylor introduced the information-driven design method for work optimization: all task aspects were tested, measured, and refined until the best way of doing the task was found. On the other hand, it ignored individual worker factors like psychological needs: for instance, the meaningfulness of work, work autonomy and degree of participation in decision-making have been identified as motivational factors. (Buchanan & Huczynski, 2019, p. 277, 459.)

For further development of modern economies, Taylor introduced the use of knowledge in work productivity: in manufacturing, knowledge was about tried and tested ways of doing a task to achieve an optimal level of productivity (Drucker 1999, p. 80-81). As emphasis has increasingly shifted from manual manufacturing to knowledge-intensive and service-based work due to economic, technological, and societal developments in the 20th and 21st century, the importance of knowledge in productivity has grown too. Drucker (1999) defined key factors which impact knowledge work productivity: first, each worker needs to determine the task to focus on; second, worker autonomy is a must-have to take responsibility of personal productivity; third, continuous innovation has to be part of the work and responsibility of the workers; fourth, continuous learning and teaching by the workers is required; fifth, the productivity is not (primarily) about quantity, as quality is at least as important; and finally, the workers need to be appreciated in the organization as an asset rather than a cost to ensure their commitment. The requirements are almost the opposite of those of Taylor's manual worker. (Drucker, 1999, p. 84, 88.)

2.3.2 IT as part of knowledge work

Although Drucker's (1999) definitions of knowledge work predated the rise of digitalization of the 21st century, later research have acknowledged them in analysing the impact of IT in work. For instance, the digitalization of knowledge work (Shujahat et al., 2019)

and knowledge work in a digital environment (Vuori et al., 2019) have been researched, while Okkonen et al. (2018) link knowledge worker as deeply immersed in the digitally rich, ubiquitous workspace. Digital skills by the workers are top-rated (Muzam, 2022), and IT tools provide better resources for knowledge work by making information more easily available (Vuori et al., 2019). Also, using IT in communication and collaboration enables asynchronicity, mobility, and individual work patterns and habits (Okkonen et al., 2018). Achieving the benefits depends on the identification of improvement needs such as bottlenecks in using time or information resources efficiently or improving work processes or interaction with co-workers (see Figure 7). Besides IT, changes in the ways of working are required in work and organization to introduce the benefits. (Castrén et al., 2013, p. 79.)

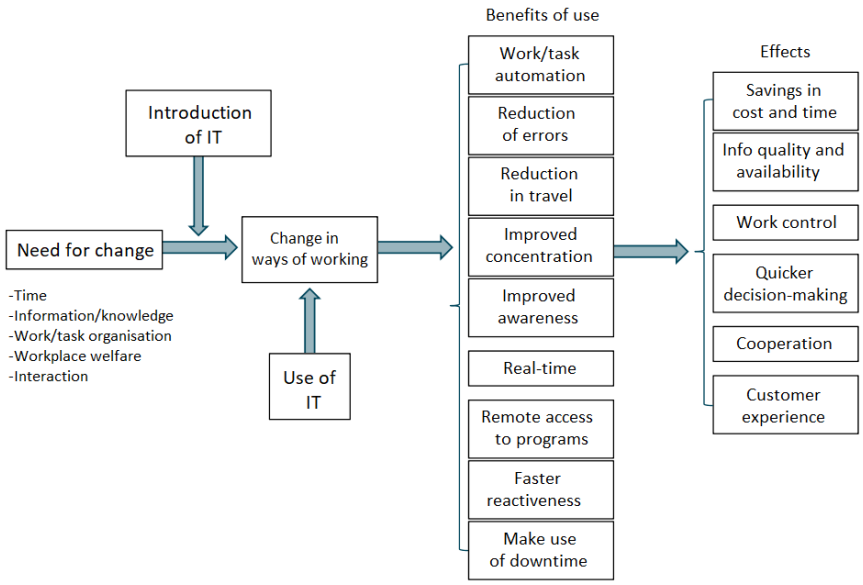

Figure 7. The impacts of IT in knowledge work (Castrén et al., 2013, p. 79).

Researches on the impacts of IT on knowledge work complement the previous considerations. Research by Okkonen et al. (2019) on how digitalization changes work according to employees found several benefits and hindrances. Castrén et al. (2013, p. 106) found that when IT sped up knowledge-based work and was applicable based on end-user needs, it resulted in stronger motivation and less frustration in work, and vice versa in adverse cases. Qualitative and quantitative research by Vähämäki et al. (2019) on how

production work is changed by robotic automatization underlined the disruptive nature of ITs on the consistency of worker task performance due to the stress involved in learning the technology which rolls into procedural practices: the digital transformation consisted of intermingled technological (applications, systems, and robotics), procedural (such as handling a service order) and organizational dimensions. (Vähämäki et al., 2019, p. 126, 131.) The results demonstrated that effectiveness and consequent productivity depended on perceptions by the employees to adapt to digital change: worker experiences with new technologies determined motivation and consequent productivity, as technical disturbances and pressures for change (negative adaptation spiral) and enlightening learning experiences (positive adaptation spiral), which adjust self-efficacy, were shown as contributing accordingly to processual productivity (Vähämäki et al., 2019, p. 126, 131).

Due to the intangible nature of knowledge work, measuring its productivity is challenging as acknowledged by Drucker (1999, p. 94), not to mention the additional challenge presented by the intangible nature of IT used in the work. Need for more holistic methods to determine the effects of IT in knowledge work has been identified in recent researches. Originally, Drucker (1999) suggested (in somewhat Taylorian way) trial and error piloting to determine which factors impact on the productivity of knowledge work. To conclude whether expected outcomes by using IT are met and potential issues in the digitalized processes can be identified early on, Vähämäki et al. (2019) suggested the quantitative and qualitative follow-up of digital transformation, particularly the impacts on worker-task interactions. Vuori et al. (2019) defined non-quantitative, digitalization-impacted knowledge work factors which may enable (e.g., autonomy, mobility) or restrain (e.g., information overload, time management issues) productivity, efficiency, and use of knowledge in work which determine work performance (see Figure 8). The model complements the findings by Castrén et al. (2013) and Vähämäki et al. (2019) on motivational factors in use of IT. As the elements of the model indicate, the factors require qualitative approaches in the acquisition and analysis of information.

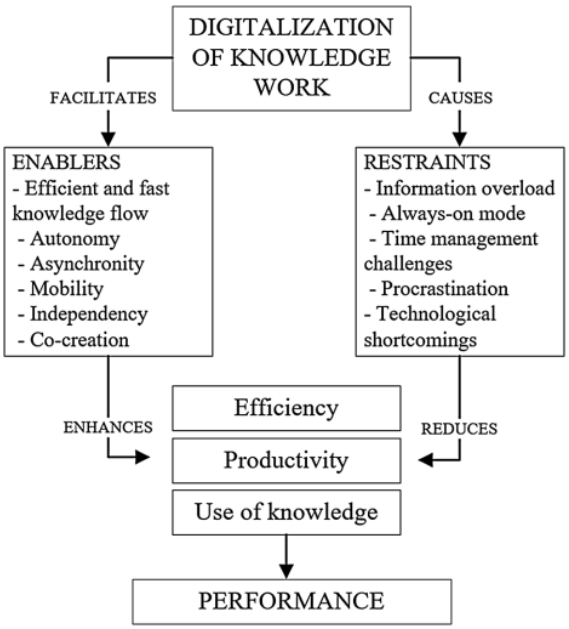

Figure 8. The effects of digitalization on knowledge work performance (Vuori et al., 2019).

Furthermore, Drucker (1999) underlined the importance of organizational dimension in making knowledge work productive, including transformation in attitudes on the nature of work across the organization. According to Harris (1994), analysis on productivity linkages should encompass several aspects of organizational performance such as efficiency, quality (including work life) and innovation: focusing on a single performance criterion like productivity does not provide a complete picture of the effects of an organizational intervention like digitalization, even if the sole goal of the intervention is to improve productivity. For instance, enhancing measurement with ITs may provide information faster and more accurately, but without considering other organizational aspects it may turn counterproductive: IT-based measurement has been depicted in some scenarios as starting an era of Digital Taylorism, where automation and remote monitoring of workers with always-on availability, information overload, and time management issues make work limiting instead of facilitating it (Okkonen et al., 2019; Schumpeter, 2015). As the previous researches have demonstrated, holistic approaches covering mutually complementing and dependent worker and organizational dimensions should be applied in the introduction, adoption and use of ITs to determine their effects as part of the work.

2.3.3 Impacts of the COVID-19 pandemic on IT-based knowledge work

The COVID-19 pandemic emerged in early 2020 and spread at the unprecedented scale and speed with devastating effects: according to World Health Organization, by 31 May 2022 over 529 million cases had been confirmed with over 6.28 million deaths across the globe (WHO, 2022). The pandemic transformed societies as governments attempted to curb the spread with social distancing to minimize human contact, the closure of places, encouraging remote work and restricting access to public spaces; movement restrictions on and controls during travelling; and public health measures such as the provision of healthcare and information (Statista, 2020). As physical economic activity came to a halt as a result of social distancing, it increased use of digital channels and accelerated work digitalization as the result of remote work (Claeys & Demertzis, 2021; Döhring et al., 2021). As an example, social media tools for remote communication like Facebook Messenger and WhatsApp increased 50 % overnight due to the pandemic (Aral, 2020). The current digitalization is driven by further automation, IoT, big data and AI (Döhring et al., 2021).

Depending on the investments in digitalization and intangible capital complementaries, labour productivity is expected to have pronounced growth during the post-COVID-19 phase (Döhring et al., 2021; Roth, 2022; van Ark et al., 2021). Due to the pre-existing productivity paradox and known specifics of IT-based knowledge work prior to the pandemic, increasing digitalization during the pandemic has raised the need for further consideration over the areas. Findings on the dual impact of IT on knowledge work in relation to productivity, for instance, had been addressed by Vuori et al. (2019) and Vähämäki et al. (2019), among others, and the pandemic has forced organizations to pay more focused attention on the matter, particularly since some changes have or are projected to become permanent: for instance, digitalized remote work as a forced adjustment for a large portion of workers (an average of 35 %) will not reverse fully when the pandemic ends (Claeys & Demertzis, 2021). One reason is that remote work has been acknowledged in increasing work autonomy and independency in managing personal work as positively related to productivity. Yet, materialization of benefits like improved

work productivity by employees requires design, preparation, and adaptation by workplace organizations including equipping their members with sufficient skills for remote work, which in turn supports work-life balance and reduces the possibility of the digital divide (i.e., unequal distribution of IT means and skills to use IT). (Claeys & Demertzis, 2021; Galanti et al., 2021; van Ark et al., 2021.)

While organizations have been forced to adapt due to the environmental circumstances beyond of their control, this has also arguably facilitated the clarification of the costs and benefits of digitalization in determining investments by each organization, which pertains directly to the topic of intangible capital and how it contributes to value added (Claeys & Demertzis, 2021). As knowledge-based work is increasingly expected to contribute in value creation including improving productivity, the investments require evaluation on how IT will improve knowledge-based work; also, as knowledge work becomes increasingly digitalized with the use of IT, it involves combining the core (possibly non-IT) knowledge and skills with those of IT and complementary methods, which development and maintenance should be part of the investment focus as well. As has been founded by research such as Harris (1994) previously, the focus requires organization-wide perspective and approach to be effective in respect to the goals like improving productivity. For this purpose, van Ark et al. (2021) define on leveraging COVID-19-generated wave of digitalization in improving productivity during the post-pandemic period that organizations “must … create the capacity to absorb and apply technology by way of a skilled workforce”, and to make the necessary “investments in organizational capabilities such as agility and resiliency and a strong innovation culture.”

3 Research design

The previous chapter defined the conceptual basis and theoretical framework on the issue of productivity paradox including in the case of Finland, and the nature of knowledge work as enabled by the increasing use of IT. The interrelated research areas form the context for studying digital work productivity in Finnish organizations from the perspectives of their individual members, since their unit level is where work or labour productivity gets materialized as result of their work. To conduct such study, the applied methodology draws from the approaches which the researches defined in the section 2.6 have used or suggested being used in determining the impact of IT in work which is increasingly becoming intangible, knowledge-based, and having a greater role as part of expectations in increasing work productivity. The research methodology choices to collect and analyse primary data for this purpose is introduced in this chapter: first, the selected case is presented with motivation. After that, the research strategy and method of the empirical study are defined, and the research sources and primary data collection are introduced. Finally, the validity and reliability of the research are addressed. Figure 9 provides the structural overview on how the different stages of the research progressed.

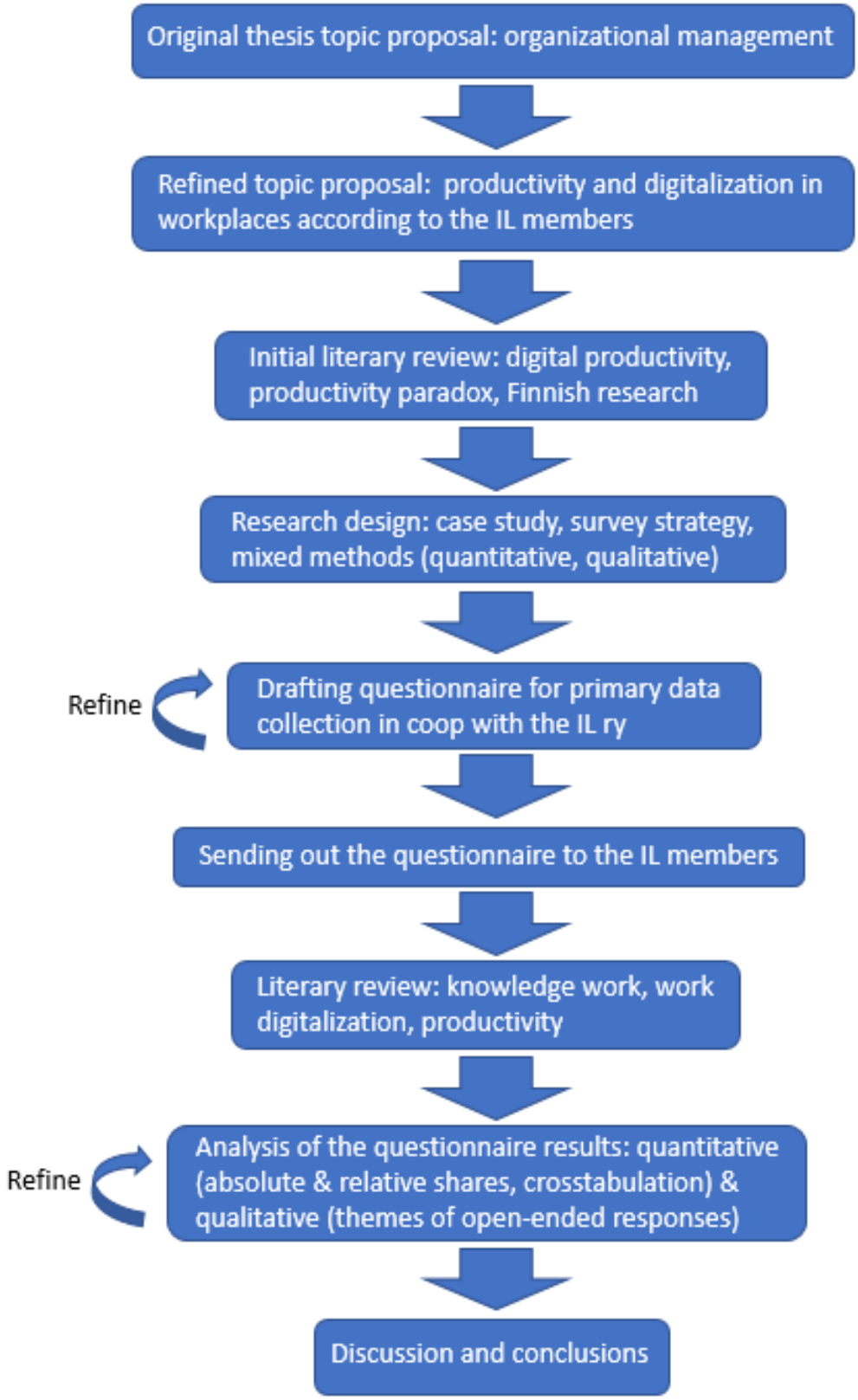

Figure 9. The research structure based on progress of the research phases.

3.1 Research case

The case to be researched was selected as a result of discussions with representatives of the Union of Professional Engineers in Finland (Insinööriliitto IL ry in Finnish) during autumn 2021. The IL is a trade union which has 73,000 individual members including 58 % engineer members, 10 % IT members, 27 % student members, and 5% other members. About 90% of the members of the Union work in the private sector. The main industries are technology, design, and information technology. The IL has functioned for 100 years as a platform for professional activities and promoting the interests of engineers and other technical professionals. (IL ry, 2022a, 2022c.)

Original proposal on the study topic related to selected areas of organizational management in Finnish organizations as perceived by the IL members. As result of the discussions with the IL management, the topic was refined to focus on the relation of productivity and digitalization in the organizations as perceived by the members in their workplaces as knowledge-work professionals, since this was determined as presenting an opportunity on introducing information on the issue of productivity paradox from unique perspective to complement previous researches. As defined in the literature review, the issue of productivity paradox has been researched from macroeconomic perspectives in particular, without comprehensively pinpointed on being as result of specific cause or certain causes alone. The organization theory-oriented work-life studies using mixed methods have provided knowledge-work oriented insights on how ITs are perceived according to their benefits and challenges for work productivity. Given the importance of knowledge and use of ITs as part of their professional roles and work contexts, the insights by the members of IL are therefore highly instrumental in contributing to the research area.

3.2 Research strategy and methods

In general, research is carried out by using a research strategy or strategies, which choice is guided by research question(s) and objectives. The rule on a choice of research

strategy or strategies is to achieve a reasonable level of coherence throughout the research design that answers research question(s) and meets objectives. Research strategies are not mutually exclusive, hence combining different strategies is feasible. (Saunders et al., 2019, p. 190.) Due to the research context and focus, a combined, mixed method research approach involving case and survey strategies was adopted.

Case studies are useful in obtaining an in-depth, multi-faceted understanding by explaining, describing or exploring a contemporary and oft-complex issue, event or phenomenon in interaction with its real-life context to introduce rich empirical descriptions and development of theory. Identification of what is happening and why in a situation as well as grasping full implications of a case often involves acquiring both qualitative and quantitative data from different sources. Due to this, the value of case study research has been widely recognized in the fields of business, social sciences, and policy. (Crowe et al., 2011; Saunders et al., 2019, p. 190, 197; Yin, 2009.) Similar to case study research, surveys are used to answer “what”, “who”, “where”, “how much” and “how many” questions, and they allow the collection of standardized data from number of respondents economically for easy comparison. (Saunders et al., 2019, p. 193.) Surveys involving questionnaires are often used in collecting quantitative data, yet they can be also applied in primary data gathering for qualitative analysis, for instance, by the use of open form where the subjects respond as they wish (Mills et al., 2010, p. 125-126). This research can be described as instrumental case study to introduce complementary understanding of an identified issue or phenomenon from the perspective of the described context, while also having potentially intrinsic dimensions to learn about unique (while already identified) phenomenon (Crowe et al., 2011).

This combination of the two strategies is known as case study survey, which as a research design is administered in form of questions related to a case involving either a small sample or an entire population of individuals. Their responses to the questions are analysed to describe population trends or to test questions or hypothesis in light of identified opinions, behaviours, abilities, beliefs, or knowledge. (Mills et al., 2010, p. 125-126).

The mixed method approach was complemented by adoption of convergent design in context of questionnaire variant (also known as data-validation variant): that is, in addition to acquiring quantitative data, open-ended, qualitative questions were included to complement the research further, as resulting qualitative data in form of quotes provide emergent themes that can be used to validate and define the quantitative survey findings. Data collection in a mixed methods case study typically involves collecting both quantitative and qualitative data that help to provide evidence for a case or cases or to generate a case or cases. (Creswell & Plano Clark, 2011, p. 81.)

3.3 Research sources

To establish theoretical foundation based on literature review in the first phase, the initial research about previous research was done by using Google Scholar. Cited by-definitions were used to determine relevance and appreciation among scholars as a factor of validity of the source information. Additionally, following online sites and databases were used in information search: ACM Digital Library, Emerald Insight, IEEE Electronic Library, ResearchGate, SAGE Journals, ScienceDirect (Elsevier), Springer Link, Taylor & Francis Online, Wayback Machine and Wiley Online Library. Also, official studies as released by Finnish organizations and research groups including the Bank of Finland, the Finnish Productivity Board, the Ministry of Finance, the Ministry of Economic Affairs and Employment, and the Prime Minister's Office, for instance, were used to acquire official information regarding productivity growth and digitalization in Finland. Primary data as the main research source of this thesis is covered in detail in the next section.

3.4 Primary data collection

In line with the chosen research strategy, the questionnaire which was to be sent out to the IL members was structured with following categories of consecutive questions:

- personal background
- workplace background
- utilization of information technology in workplace

- IT skills and training opportunities
- IT in workplace during the COVID-19 pandemic
- performance monitoring, work productivity, and costs of IT in workplace

The questions on personal background covered personal characteristics and status (age, gender, living residence), the latest degree, work experience in years, and current employment status. The questions on workplace background covered the field of current workplace, the number of people working in Finland, whether the workplace was a foreign-owned company, and whether the workplace had outlined digitalization in organizational strategy. These questions introduced contextual factors about workplaces, followed by questions on the utilization of IT in workplace: the participants who had answered “Yes” on the question of digitalization as part of the strategy were asked about the aims in detail. Next, questions on specific ITs and related methods used in workplace, participation in their selection and digitalization in workplace in 2-5 years and areas of impact by IT was asked: these questions provided context on what ITs and related methods have been recognized in workplaces, and what areas have been impacted by them based on perceptions by the respondents.

The questions on IT skills and training opportunities covered topics on time spent on developing IT skills during the past year, personal IT skills development methods and their need and application in work tasks, and means of IT skills acquisition by the workplace organization. Regarding questions on IT in the workplace during COVID-19, the impact of pandemic on work and productivity involving the use of IT was asked. Finally, the part of the work productivity of IT in the workplace covered questions on monitoring performance of IT and related methods in workplace, productivity and cost impact of the introduction of IT and methods, and other factors which have influenced work productivity.

The questions included selection, multi-selection, open-ended, Likert scale selection, and numeric questions. Several open-ended questions were combined with selection and multi-selection questions to allow the respondents to provide further information

besides the selection options. The total number of questions was 29, which was recognized as making the questionnaire lengthy and potentially impacting the response rates: in general, too many questions can result in questionnaire fatigue by the respondents who may quit the questionnaire before reaching till the end (Saunders et al., 2019, p. 194, 305). Also, sometimes questions may not be applicable to respondents, who then bypass them altogether. The trade-off was made to ensure good amount of responses with sufficient detail and to allow the respondents to leave certain questions unanswered in case they were not seen as applicable. Most of the questions were shown to all respondents, the only exception being the follow-up question on digitalization in organizational strategy (Question 13, see Appendix 3), which was shown to the respondents who answered "Yes" on the question of digitalization in organizational strategy (Question 12, see Appendix 3). The question on digitalization aims was designed to introduce insights on digitalization strategy in the workplaces: i.e., was productivity among the strategy goals, and what other goals might be involved. The questions were drafted in Finnish and in English. Appendix 3 covers structure of the English version of the questionnaire which was sent to the IL members.

The questionnaire was designed and implemented as an online questionnaire form by using Webropol 3.0. Before sending the questionnaire to the IL members, the form was reviewed in December 2021 and January 2022 together with the IL management as well by external test reviewers to validate grammar and concepts in the context, and it was incrementally refined until the fifth version was agreed to be sent to out. The changes related to terminology: for instance, original title of "Digitalization in organizations" was changed to "Utilization of information technology in workplace" to make the scope more tangible for the respondents. The definition of "employer" was changed to "workplace" since entrepreneurship and other similar forms of work relate to self-employment. Some questions were combined, for example, by adding open-ended questions with other questions as open-ended answer options, while too abstractive ones others were removed. Once completed, the questionnaire was sent to the IL members in last week of January 2022 with two weeks time for responding.

3.5 Validity and reliability

Reliability and validity are central to judgements about research quality. Reliability refers to replication and consistency of research, i.e. replication of an earlier research design and achieving the same findings suggests that research would be reliable, whereas validity refers to appropriateness of used measures, accuracy of result analysis and generalizability of findings. (Saunders et al., 2019, p. 213-214.) In this thesis, validity and reliability relate to primary data which was acquired by using a questionnaire, and which holds central role in evaluation in respect to the previous researches defined under the literary review and complements them further. A valid questionnaire enables accurate data that measure the concepts you are interested in to be collected, while one that is reliable will mean that these data are collected consistently. As starting point, these requirements are addressed by crafting instructions and questions by the researcher so that the respondents understand them as expected, and vice versa on the answers to the questions. (Saunders et al., 2019, p. 516.) The online questionnaire approach to acquiring primary data has benefits of being cost-efficient to implement in terms of financial and time resources and having potential to reach out wide target audience. The approach has its limits too: number of the questions needs to be limited, and they must be carefully designed to acquire results of adequate quantity and quality. The matter is important when a questionnaire is carried anonymously, which does not provide opportunity to get back to respondents afterwards: on the other hand, anonymity allows the participants to answer more openly, which may not be achievable in case of face-to-face interview, for instance.

Several revisions of the questions were carried out to ensure that the understanding could be achieved as closely as possible. Also, the respondents were provided with contact information of the thesis writer and IL management in case of need for clarification about the questions. Since no contacts occurred, this suggests that the questions were understood by the respondents in principle; however, this does not exclude possibility of misunderstanding of certain questions. The received answers included similar format

which indicated that the questions had been understood, which confirmed them as having appropriate test-retest reliability. Also, these answers were found to have good amount of adherence to the theoretical elements introduced in the literature review, which indicated certain construct validity. However, as other forms of and measures for primary data gathering was not carried out due to research resource limitations, further content validity could be introduced, for instance, with face-to-face interviews which would contribute further with improved validity and reliability via data triangulation.

4 Results

In this chapter, the results of the primary data collection which was carried out with questionnaire are introduced: in the first section, initial quantitative analysis is covered and complemented with descriptive statistical analysis using crosstabulation for further insights. The responses to open-ended questions are analysed by conducting thematic analysis for establishing qualitative data insights. In the second section, follow-up analysis is done across the quantitative results to generate further insights. Most of the responses were translated from Finnish to English. As for non-responses, particularly optional open-ended questions received fewer answers. In general, the answer rate was good, producing fair amount of primary data for analysis.

As certain responses were originally distributed across several categories, after initial analysis it became clear that too detailed data granularity limited finding trends which might get manifested on other level. Besides the dispersion of data across similar categories, certain employment statuses and workplaces were represented more than others, and smaller number of certain responses made comparison challenging. To facilitate further analysis, current employment areas (see Appendix 1) were recoded into two professional role categories, managerial role and specialist role: the managerial role included top management, upper and lower middle management, and entrepreneur or other independent role/position, as these roles involve managerial tasks and responsibilities, and the specialist role covered experts, office holders and other roles/positions, which based on the answers indicated this role category as appropriate. Also, current workplaces were recoded into private and public sectors: the private sector included the fields of industrial operator; engineering, design, or consultancy agency; IT based services or game industry; commerce or other service sector; and other in private sector. The public sector included municipality, association of municipalities or government/state, and other in public sector. This recoding was based on whether public sector was specifically reported by the respondents: in case other fields than the fields of the public sector were reported, they were assigned to the private sector. Also, the field of

healthcare was assigned to the private sector as 2 out of total of 3 respondents had responded “Yes” on the question of “Is your workplace a foreign-owned (over 50 %) company?”, hence making them privately owned workplace organizations.

4.1 Questionnaire results

4.1.1 Respondent background information

The total number of responses received was 340, out of which 330 replied as currently employed, which was the core group of study focus of the survey. As for demographics detailed in Appendix 1, the largest age group reported was 36-50 years, followed by 51-60, 18-35, and 61 or older, respectively. Regarding gender, almost 80 % were males, and around 19 % were females. On education, over 63 % reported Bachelor of Engineering (AMK-insinööri in Finnish) degree, vocational degree (11,5 %), university degree such as M.Sc. or MBA (10,3 %), other polytechnic degrees including higher AMK degree (9,4 %), and upper secondary education degree (5,5 %). The previous answers included all 330 respondents since the questions were mandatory. Following questions were not mandatory, which was reflected in the total number of answers: hence, the context of the numbers is introduced in each case separately. Appendix 1 includes distributions of work experience after the latest graduation, in current employment and in total, as well as current employment positions. Expert and middle management roles were reported by over 60 % and 29 % of the respondents, respectively.

Based on comparison with statistics from a survey conducted by the IL in 2021, the acquired distributions on gender, age, and employment positions by the IL members are in line with the information on the previous responses, which verifies the representation of the members as valid (IL ry, 2021b). Moreover, the information by the IL on technology-oriented workplace sectors is aligned with the information received from the respondents (IL ry, 2022c). Also, based on the background information about education, it can be deduced that the IL members are professionals whose work involves acquiring information and applying it as well as leveraging previously acquired knowledge further.

Work roles and experiences stood for opportunity for insights from different perspectives as well as potential in introducing aligned themes.

4.1.2 Workplace background information

Next, workplace organization questions on the field, the workplace size in number of employees, the ownership, and digitalization as part of organizational strategy were asked. According to Table 2, the respondents working in industrial operator-based workplace organizations are the largest group, with IT-based services or game industry and engineering, design, or consultancy agency being next, which in total make over 3/4 of the responses: these fields are perceived as being technology-intensive, i.e., work involves using technology with relevant knowledge in creation, production and delivery of products and services, and they mostly include private companies. The latter matter is confirmed by statistics of the previous survey by the IL, which stated that the 90 % of the members work in private sector, and 10 % in public sector (IL ry, 2021b).

Table 2. The fields of current workplaces according to the respondents.

	n	Percent
Industrial operator (domestic or foreign market)	121	37,1 %
Engineering, design, or consultancy agency	61	18,7 %
IT-based services or game industry	69	21,2 %
Commerce or other service sector	14	4,3 %
Healthcare	3	0,9 %
Municipality, association of municipalities or state	21	6,5 %
Other in public sector, what?	19	5,8 %
Other in private sector, what?	18	5,5 %

Other public sector fields included education (8), public-sector company (4), infrastructure, maintenance or transport (4), and church (1). Other private sector fields included construction, infrastructure, and maintenance (9), education (4), and investment (2). The

largest group of the respondents work in organizations with 1000 or more employees, with 100-499 and 500-999 employees as the next largest categories (see Table 3).

Table 3. The workplace employment in Finland in numbers according to the respondents.

Number of employees	n	Percent
1-29	45	13,8 %
30-99	25	7,6 %
100-499	88	26,9 %
500-999	49	15,0 %
1000 or more	120	36,7 %

The question on whether the workplace is a foreign-owned (over 50%) company was asked with “Yes” and “No” answers. Out of 327 respondents, 108 (33 %) respondents answered “Yes”, 219 (67 %) answered “No”. The question on digitalization as part of organizational strategy was asked to indicate awareness on the strategy dimension. As shown on Table 4, although over 57 % of the respondents answered “Yes”, the amount of “I do not know” answers (over 1/4 of total answers) suggests that the awareness may not be definite, which raised questions of organizational strategies and their implementation.

Table 4. The distribution of the responses to question “Has your workplace outlined digitalization in organizational strategy?”.

	n	Percent
Yes	189	57,8 %
No	54	16,5 %
I do not know	84	25,7 %

To gain information on how the results on Table 4 are related to different organizational contexts, the organizational sizes in terms of number of employees and the workplace fields were crosstabulated with the table results. Below, Figure 10 on the number of

employees (326 responses in total) shows that workplaces where the “I do not know” answers amounted 24 % or more had 1-29, 30-99, 100-499, and 1000 or more employees, except workplaces with 500-499 employees totalling 16,3 %. The “No” answers totalling 20 % or more included workplaces with 1-29 and 30-99 employees, while the “Yes” answers totalling 57 % or more were reported in workplaces with 100-499, 500-999, and 1000 or more employees: this indicates that organizations with greater number of personnel have more often digitalization defined as part of the strategy. The high amount of “I do not know” answers (over 1/4 across several size categories) suggests unawareness about the digitalization as part of strategy, the strategy itself, or both: more specifically, given the different professional roles by the respondents (see appendix 1), for instance, some may be more aware of the strategy than others due to their closer positioning in respect to strategy formulation work in the organizations.

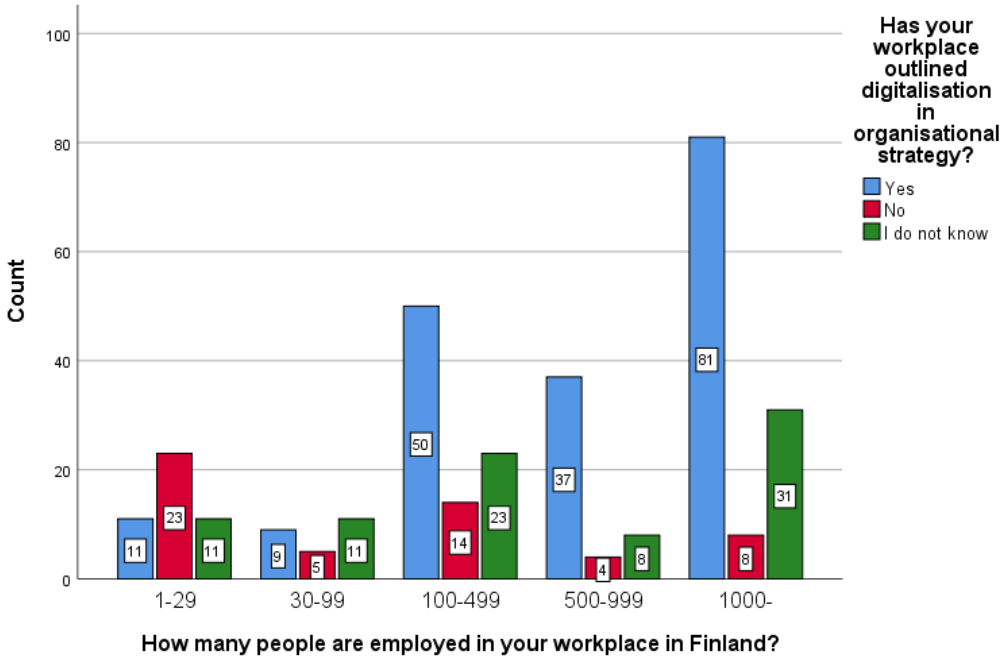

Figure 10. The results of the crosstabulated responses to the questions on digitalization in organizational strategy and number of employees in workplaces.

Furthermore, as shown on Figure 11 current workplace responses (total of 325) indicate that the fields where the “I do not know” answers amounted 25 % or more were engineering/design/consultancy, healthcare, municipality/association of

municipalicities/government, and IT based services and game industry. The fields where "No" answers amounted 20 % or more included commerce/other services, healthcare, and industrial operator. The "Yes" answers with rate of 57 % or more included other in private and public sector, and IT based services and game industry. The high amount of the "I do not know" answers in respect to "Yes" and "No" answers in certain workplaces suggests that awareness about digitalization in the strategy may not exist widely among knowledge workers. Also, the "No" answers in particular indicate that digitalization may not be relevant in the fields which have not been traditionally IT-driven but more dependent on other inputs of production. The "Yes" answers of public sector included educational institutions, where IT is used in study tracks and teaching, while private sector included infrastructure building, construction and contracting, and other services in general, which may be due to their business such as building and maintaining IT infrastructure.

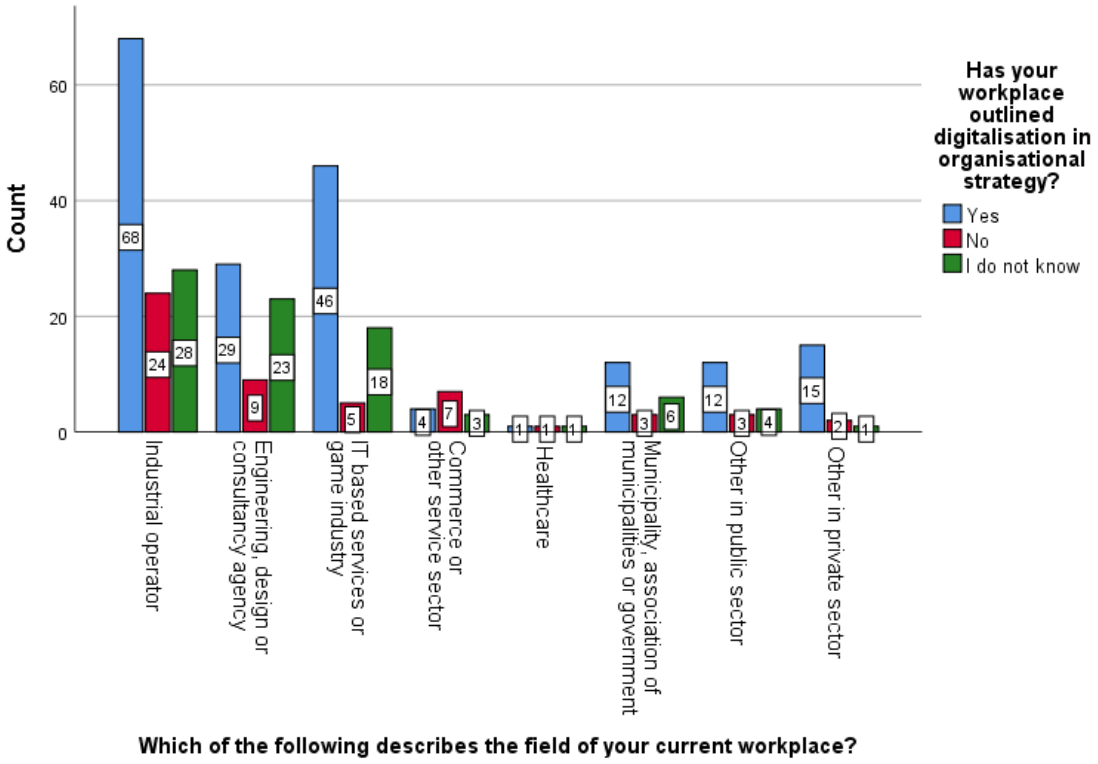

Figure 11. The results of the crosstabulated responses to the questions on digitalization in organizational strategy and fields of workplace.

4.1.3 Utilization of information technology in workplace

In case the respondent had answered “Yes” to the previous question on digitalization in organizational strategy, the next question was presented about strategic digitalization aims in workplace organization. Distribution of the responses is shown on Table 5.

Table 5. The distribution of the responses to proposition “According to my workplace strategy, digitalization aims to…”.

	n	Percent
reach out new markets and/or customer segments	109	59,2 %
improve current productivity	141	76,6 %
maintain current level of productivity	45	24,5 %
staying in the competition	100	54,3 %
regulatory compliance, what exactly?	7	3,8 %
something else, what?	12	6,5 %

Most respondents acknowledged improving productivity, reaching out new markets and/or customer segments, and staying in competition as the top-most strategic goals which digitalization is expected to contribute for, which are typical themes to private companies in particular. The highest number of improving productivity, though, raised concern that the described topic of the questionnaire may have impacted in generating the related answers, a phenomenon which has been recognized with other survey researches in the past. In any case, the interesting distribution of answers resulted for the options of “improve current productivity” (141) and “maintaining current level of productivity”(45), which appeared as alternative options in light of total numbers compared to the “Yes” answers (189) on the question on digitalization in the strategy. Crosstabulation with the options revealed though, that both options were selected by 38 respondents, 102 selected improving productivity only, and 6 selected maintaining productivity only (see Table 6): the numbers indicate that the two options are not mutually exclusive after all. Further crosstabulation revealed that while most of the workplaces in absolute numbers appear to pursue the improvement strategy as the main approach,

majority of the fields have organizations with the dual approach: this could be due to leveraging digitalization in existing areas of productivity where incremental improvement such as the maintenance is required, while also having the improvement involving the areas but also new ones as enabled by the introduction of IT. Also, this could relate to the trialling of ITs to determine their potential, i.e., to see whether they can be used in either maintaining or improving productivity, or both.

Table 6. The results of the crosstabulated responses on the workplace fields and the productivity responses (maintain, improve) to proposition "According to my workplace strategy, digitalization aims to.." (x = answered, - = unanswered).

		Maintain current productivity		
Current workplace?	*Improve current productivity*	-	x	Total
Industrial operator	-	7	1	8
		87,5%	12,5%	100,0%
	x	44	14	58
		75,9%	24,1%	100,0%
Engineering/design/consultancy	-	5	1	6
		83,3%	16,7%	100,0%
	x	18	5	23
		78,3%	21,7%	100,0%
IT based services/game industry	-	13	1	14
		92,9%	7,1%	100,0%
	x	20	11	31
		64,5%	35,5%	100,0%
Commerce/other service sector	-	2	0	2
		100,0%	0,0%	100,0%
	x	0	2	2
		0,0%	100,0%	100,0%
Healthcare	x		1	1
			100,0%	100,0%
Municipality/association of/gov	-	2	0	2
		100,0%	0,0%	100,0%
	x	6	3	9
		66,7%	33,3%	100,0%
Other in public sector	-	5	2	7
		71,4%	28,6%	100,0%
	x	5	0	5
		100,0%	0,0%	100,0%
Other in private sector	-	3	1	4
		75,0%	25,0%	100,0%
	x	9	2	11
		81,8%	18,2%	100,0%
Total	-	37	6	43
	x	102	38	140

In case of the open-ended options, for regulatory compliance industry and ISO standards, compliance with requirements, information and cybersecurity, and GDPR were outlined. For “something else, what” better and versatile customer experience, involvement in developing digital services, sustainable development, and provision of the previously listed options to other companies were defined. Regulatory compliance received few responses, which suggests that it is not among the main drivers in digitalization as part of the strategy in most cases.

Next, the question on ITs used in workplaces addressed the topicality of forms of digitalization which have emerged into IT trend discussions during past decades. To analyse data further to find emphases of ITs, the two options on potential identified (see Appendix 3, question 14) were combined into one. Same was done for the options of used 1-2 years and used over 2 years, which were combined into the option of used 1 or more years. The combinations of the options are visualized on Figure 12. The “Something else, what?” option provided 7 answers: “machine learning”, “situation management, possibly in real-time”, “quantum computers”, industrial process and data modeling, 3D modeling, and “online teaching”.

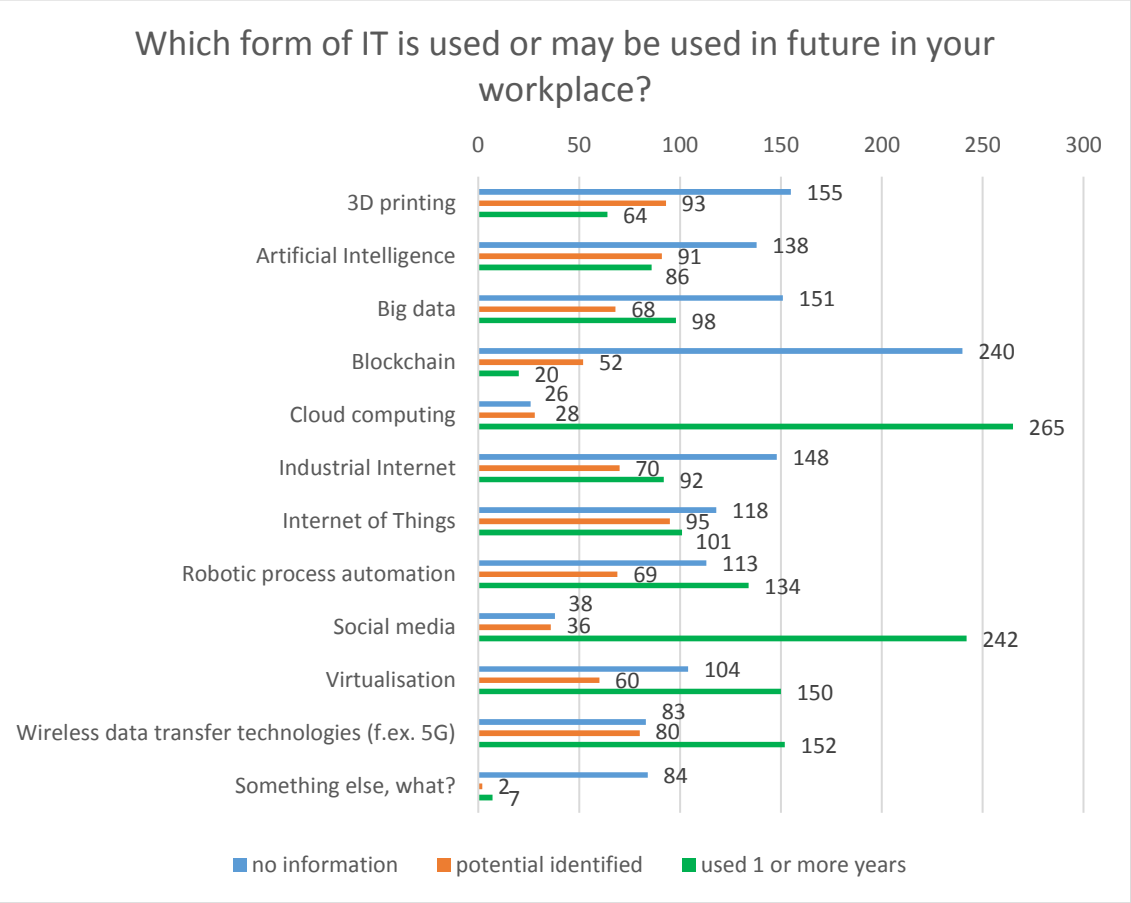

Figure 12. The distribution of the responses to question "Which form of IT is used or may be used in future in your workplace?".

As Figure 12 indicates, certain ITs were widely acknowledged across workplaces as used for 1 or more years. In case of social media, further crosstabulation with the fields of workplace demonstrated over 50 % rate involving other in private sector (88,9 %), industrial operator (78,6 %), engineering (70,2 %), commerce/other services (78,6 %), IT based services or game industry (68,7 %), municipality/association of municipalities/government (95,0 %) and other in public sector (89,5 %), while healthcare totalled only 33,3%. The rates may be due to the fact that social media can be adopted relatively easily and its wide adoption by people inside and outside of the organizations. In case of healthcare, use of online social media may be less relevant part of the work than being physically present on-site (an area which should be researched further due to small absolute number of answers in this study). Similar adoption rates resulted for cloud computing, where

most fields stood out between 78 % and 95 % of adoption for one or more years, with exception of healthcare (66%).

The adoption rates suggest that certain ITs have become more widely diffused as GPTs since their introduction in the 2000s, while others such big data and artificial intelligence are yet to emerge more widely and beyond of certain fields. An interesting result was the high number of “no information” answers on big data which has been among emerging IT trends: unsurprisingly, “used for over 1 years” scored highest on IT based service sector with (47,8%), while “no information” scored highest in commerce sector with (78,6 %), which may not be surprising due to traditionally perceived non-IT intensiveness of the field: still, analysis of big data as provided by customers could enable improvement of products and services and in turn improve productivity. Another difference related to AI which was mostly used for 1 year or more in IT based services or game industry (44,1 %), while being lower in industrial operator (19,0 %) and engineering sector (15,3 %) and other in private sector (11 %). In case of industrial operators, AI may have been supplemented by more concrete robotic process automation (53,4 % for usage of 1 or more years), while engineering/design/consulting may be based on knowledge-based specialization which cannot be replaced by AI. Similarly, crosstabulation revealed financial industry and energy production for other in private sector, and the “no information” answers on the sector were mostly on construction-related, which are non-IT intensive fields which depend on human resources. The results suggest that big data and AI have not (at least as a GPT part of further innovation) emerged in Finnish workplaces as mainstream across the fields. Moreover, certain fields exhibited internal differences in adoption of ITs: for instance, although Industrial Internet totalled largest in absolute numbers for industrial operator with 1 or more years usage (38,3 %, 44/115) as might be expected, the field also topped in absolute numbers for “no information” answers (33,9 %, 39/121), which due to the Industry 4.0 focus of the field was surprisingly high. Compared to the previous number on (more traditional) robotic process automation by the industrial operators, the outcome suggests not all representatives of same field are currently engaged in introduction of latest ITs by default in similar manner.

As was done previously for the answers to the ITs in workplaces, for the answers to the IT-related work methods (see Appendix 3, question 15) the two options on potential identified were combined, and the options of used 1-2 years and used over 2 years were combined into used 1 or more years. Figure 13 covers these results. Most/least used in the fields in one or more years demonstrate the identified differences: Lean (industrial operator, 63,9 %, commerce/service, 7,1 %), Agile (IT based services/game industry, 82,4 %, commerce, 14,3%), and Just-in-Time/Kaizen (industrial operator, 40,0 %, commerce, 0%), which most likely reflects close relevance with managing IT-intensive work tasks and processes in the related fields. Also, notable were the shares of service design (other in public sector, 63,2 %, engineering/design/consultancy, 14,5 %) and human-machine interaction (IT based services/game industry, 37,3 %, municipality/association of municipalities or government/state, 5%), which are leveraged in facilitating and improving tasks involving the use of IT. Other methods were mostly unrecognized. In case of the option of “Something else, what” the only answer received was “DevOps culture and methods”. As indicated in the literature review, leveraging ITs to live up their potential involves changing ways of working, including adoption of specific methodologies which support goals in using IT like improving productivity. Given that the highest total number of answers related to “No information” option for almost all methods (except Lean), this raises the questions on whether IT-related work methods are recognized, or are they perceived as inherent part of the use of IT(s) by default (i.e. no need for facilitation by additional methods).

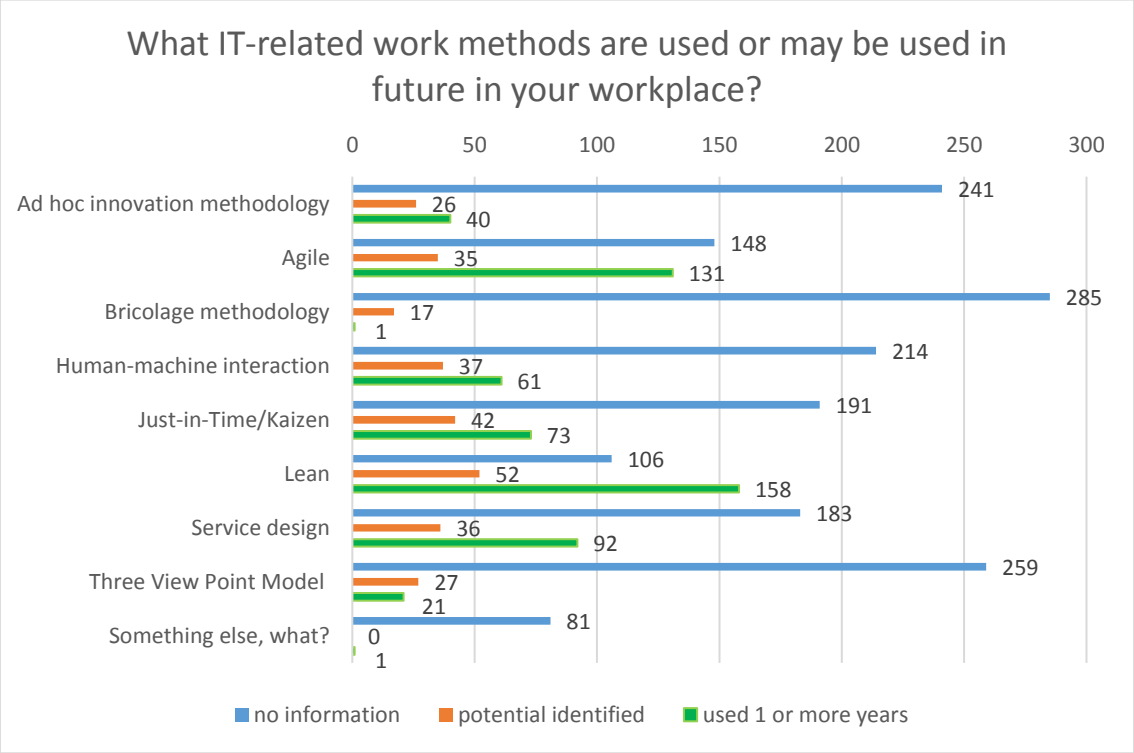

Figure 13. The distribution of the responses to question "What IT-related work methods are used or may be used in future in your workplace?".

Based on the answers regarding participation in choosing IT or methods related to personal work, decision-making over the matter appears to be beyond of professionals themselves in workplaces (see Table 7). To analyse further, crosstabulation involving the answers together with recoded current employment (managerial and specialist) status and field of current workplace was done: across all workplaces, the respondents with the managerial role have mostly been involved ("Yes": 56,4 %, 57/101; "No": 43,6 %, 44/101), while the specialist have participated less ("Yes": 37,4 %, 82/219; "No": 62,6 %, 137/219). These work role-based shares represented the overall status in most workplace fields except IT based services/game industry where specialists topped ("Yes": 55,6 %, 30/54; "No": 44,4 %, 24/54) over managers ("Yes": 46,7 %, 7/15; "No": 53,3 % 8/15) and engineering/design/consultancy where most respondents had not been participated in the process with over 63 % of "No" answers by both roles. The main trend raises the question on whether ITs are introduced through any piloting or trials involving (at least some) non-managerial personnel in the workplaces, as such activity would be

most pivotal to determine their applicability, benefits and challenges as experienced by their designated end-users before wider introduction across organizations takes place.

Table 7. The distribution of the responses to question "Have you participated (e.g. surveys) in choosing IT or methods related to your work?".

	n	Percent
Yes	140	43,5 %
No	182	56,5 %

Based on the responses shown on Table 8, digitalization efforts at workplaces during 2-5 years have focused on establishing communication enablers internally, followed by core product, service and process development, external communication and financial management. Other field(s) by the respondents included collection and measurement of IoT data, digitisation of paper-based archives, and offers/bidding. Based on the answers, innovation was lowest in healthcare (0) and commerce/service sector (15,4 %), while others scored below 50 % (industrial operator, 45,0 engineering/design/consultancy, 32,7 %; other public 40,0 %; other private 29,4 %), with exception of municipality/government (50,0 %) and IT based services/game industry (55,0 %). Based on the results, in most workplaces leveraging IT stands for digitalization of pre-existing or standardized tasks or processes, and introducing complementary means like social media in communications and robotic process automation in process development to be on par with competition and in providing products and services to customers via online channels (see Figure 12 for comparison). In contrast, innovation by using IT has been limited, which less adoption of ITs like big data and AI in workplaces as defined previously seems to reflect on their part too.

Table 8. The distribution of the responses to question “What activities have been digitalized with IT in your workplace during 2-5 years?”.

	n	Percent
Development of core products / services / processes	184	64,1 %
Product / service / process innovation (non-core existing/past)	121	42,2 %
Internal communication (e.g. strategy, team communication)	240	83,6 %
External communication (e.g. media relations)	144	50,2 %
Maintenance and monitoring of core or other activities	120	41,8 %
Customer sales	120	41,8 %
Sales (B2C, B2B, e-commerce)	89	31,0 %
Financial management	133	46,3 %
Cooperation between organizations	123	42,9 %
Other field(s), what?	11	3,8 %

Regarding the impact of introduced IT and/or related work methods, Figure 14 shows that remote working is universally acknowledged as “completely true”: using crosstabulation, over 65 % answer rate was reported in most workplace fields except commerce/service sector (42,9 %): this may relate to physical presence required in the workplace field, which cannot be substituted with online presence. On other options, the high number of responses on “to some extent true” reflect that the pros and cons have been recognized as impactful on personal work involving skill improvement, access to information, communication, and processual development, while also increasing workload or difficulties in work.

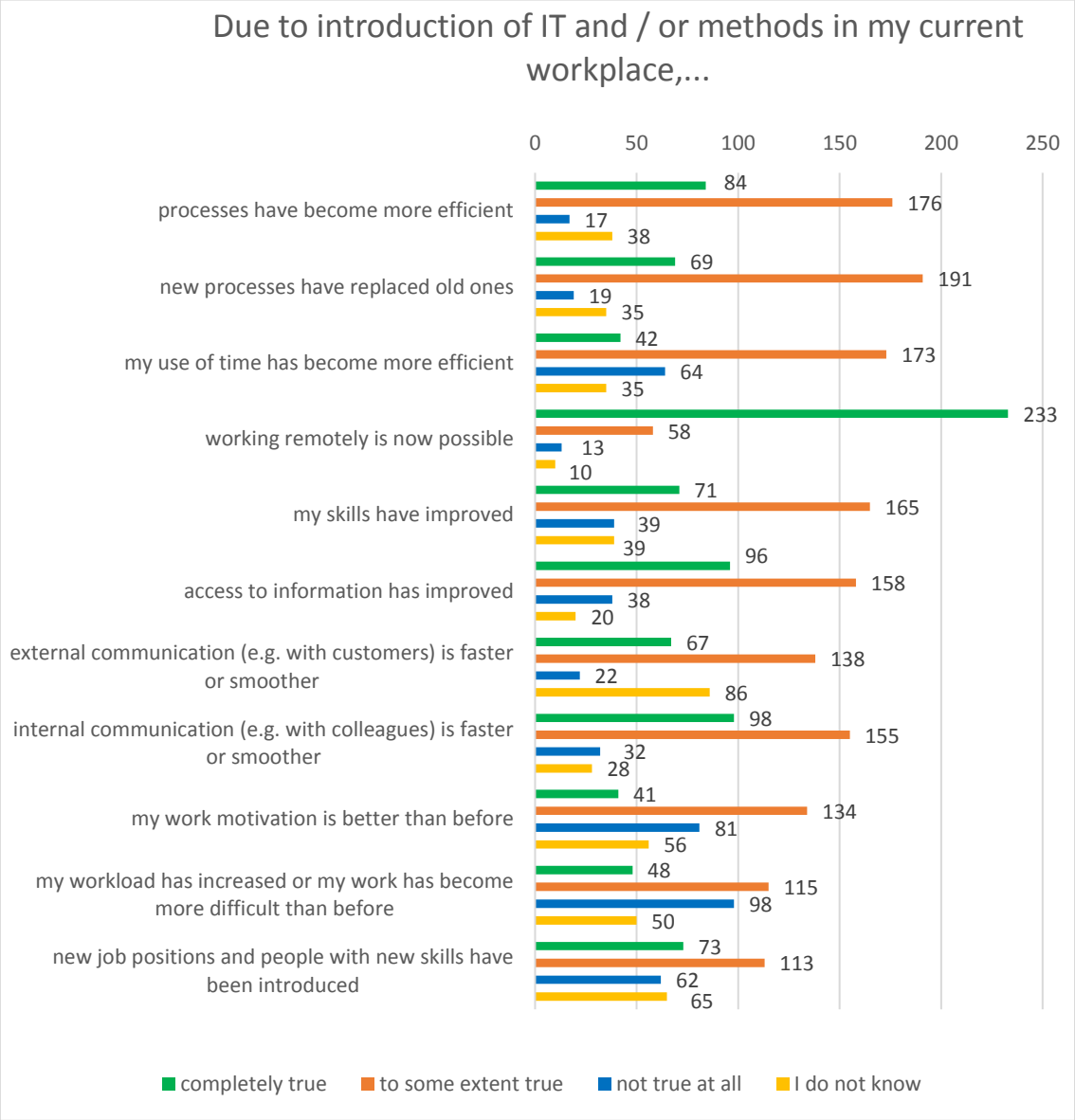

Figure 14. The distribution of the responses to proposition "Due to introduction of IT and / or methods in my current workplace,...".

Interesting results relate to answers about motivation which has been recognized among key enablers in improving productivity by the previous researches: 25 % or more responded as "not true at all", which involved other public sector (31,6), engineering/design/consultancy (29,3 %), commerce/services (28,6 %), industrial operator (25,4 %), and IT based services/game industry (25,0 %). In terms of professional roles in the workplace fields, highest (25,0 % or more) rates by the specialists involved engineering/design/consultancy (27,7 %), industrial operator (26,9 %), IT based services/game industry (26,0 %), while managerial roles involved other public sector (100%), commerce/services (37,5 %),

engineering/design/consultancy (36,4 %), and other private sector (28,6 %). According to further crosstabulation analysis, work increase or difficulty answers of “completely true” and the motivation answers on “not true at all” scored 47,9 %, with “to some extent true” 23,7 %, and with “not true at all” 23,5 % (23/98). The outcomes suggest that the motivation topic relates to the other work areas as impacted by the introduction of IT and/or related methods.

Finally, open-ended question on “Has introduction of IT and/or work methods changed working in some other way?” produced 92 responses with identified themes as shown on Figure 15.

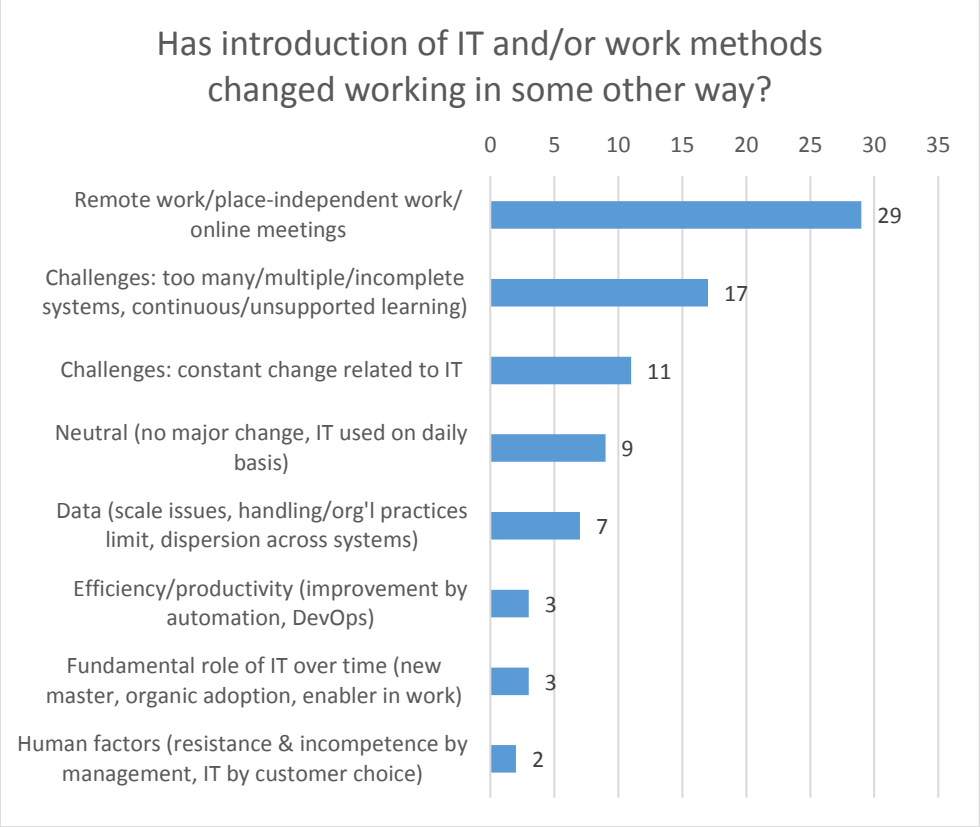

Figure 15. The distribution of the responses on impact of introduction of IT and/or work methods.

Remote or place-independent work (29 responses) was most often defined as the main change, and due to the COVID-19 pandemic. Indirect references included Teams meetings as “new normal” and “introduction of mobile group communications”, while “having

less face-to-face meetings" was seen as downside. Others defined remote mode as "working fine", as an opportunity to "freely decide about own work tasks and time, … which has improved work motivation" and "workplace can be… anyplace where I have online access". Increasing digitalization or use of IT (17 responses) included work challenges: number of IT systems was growing or had grown too large (6 responses) to be manageable (2 responses), causing extra work by multiple logins (2 responses), and consuming time in information search (2 responses) and due to lack of integration of applications (1 response). Learning new ITs was done without guidance (2 responses). New systems overlap with legacy ones, causing more work (4 responses), usability of ITs is not tested with end-users beforehand (2 responses), and systems are often incomplete (4 responses) and malfunctioning, and price or cost factors are key priorities in the selection criteria (1 response). According to a comment, "the more new 'efficiency improvement' systems are introduced, the more bureaucratic and inefficient the organization becomes, 90 % of people using the new systems are doing unnecessary extra work, for 10 % only they have made life easier." According to another comment, "Lots of … applications, some are good, others illogical and hence frustrating (focuses too much on management reporting and less on actual tasks)". Change related challenges were defined by 11 responses: "things are increasingly in a worse mess faster", "learning new things and constant change are hampering", and "to work efficiently, one needs to stay in the swim".

9 neutral responses defined "no major change during five years", "...technology has already been possible, COVID pandemic gave a push to use it", and "in an ICT company, use of IT is everyday business and 'mandatory'". Inconclusive responses defined "I cannot answer anything else", "difficult to answer…since IT has been around 20 years at least", and "Certainly status is better than for example five years ago, but I cannot instantly think how. Compared to 20 years ago, things are better now…thinking that was the culmination point passed and from now on development will get worse?". 7 responses pinpointed data/information: 3 responses acknowledged growing volumes of data including transfer issues and that "one needs to be able to filter data based on own needs". Regarding data collection, "… most of the time passes by pondering on how the

work (as outcome) information will be inserted into an application. What that information is remains a side issue, while it should be the main thing." One response concluded that "data is more centralized and in some cases more easily available. On the other hand, information seems to disperse … across multiple systems". Also, one defined that while "management and access rights control of … databases has evolved ... there exists .. restrictions to access information due to department level interpretations".

Human factor was also reflected, as "people, usually in power positions, do everything ... to slow down change or make sure they do not need to learn anything new... Many … managers … have become more anxious and their incompetence is becoming easier to see. People … (who) can barely use a spreadsheet are now expected to use more complex solutions." Another perspective highlighted that "work is mainly done in customer environment, where the customer decides what methods are used". 3 responses addressed "more efficiency", "raising level of automation of the production … has improved productivity", and "in a software company, DevOps methods make the whole chain more efficient". 3 responses summarized fundamental role of IT: "IT has become the master when it should be the servant. After all, it is just a tool which should function and be easy to use". According to other perspective, "change has not taken place in big bang style, instead we have crafted our doing in organic manner based on needs. New methods are jointly examined to determine whether they work or not, and technology serves organization, not other way around". Similar view outlined that "having worked in an IT service organization for 25 years, IT has always been present in daily work. The nature of work has changed during the time, but the fundamental idea that the purpose of machine and software is to be the enabler instead of being replacement (of the worker)".

4.1.4 IT skills and training opportunities

The first question asked "How much time you spent developing IT skills during the past year?", which was to be inputted as a numeric value in total hours spent both at work and off-work. For total hours spent at work, 266 answers included 37 different hour numbers. Table 9 contains the most often reported total hours as provided by at least two

respondents. Sector specific crosstabulation showed that 36 out of 234 respondents in the private sector and 1 out of 32 in the public sector spent 0 (i.e. did not spent any) hours, making the response rate on spent hours 84,6 % and 96,9 % respectively: the hours which scored more than one response in both private and public sectors were 100 (26+5), 20 (25+6), 40 (24+3), 10 (22+4), 50 (21+4), and 200 (10+2) hours.

Table 9. The most often reported hours spent at work for developing IT skills.

Total hours at work	Respondents
100	32
20	31
40	27
10	26
50	25
200	12
5	9
30	9
2	6
8	5
80	5
24	4
1	3
16	3
60	3
150	3
3	2
4	2
12	2
25	2
1000	2

For total hours spent off-work, 266 answers were provided in 29 different hour numbers. Listed at Table 10 are the most reported numbers of total hours as provided by at least two respondents. Sector specific crosstabulation showed that 83 out of 234 respondents in the private sector and 15 out of 32 in the public sector spent 0 (i.e. did not spent any) hours, making the response rate on spent hours 64,5 % and 53,1 % respectively: the hours which scored more than one response in both sectors were 100 (24+6), 20 (23+3), and 50 (18+2) hours, while the private sector continued to score high with 200 (12), 10

(12) and 40 (11) hours. The halving of total responses in the public sector in respect to hours spent at work indicates that most of IT skills development takes place during work, whereas in the private sector the high absolute number of responses on 0 hours spent in both categories indicates that the skills development is not relevant in all fields.

Table 10. The most often reported hours spent off-work for developing IT skills.

Total hours off-work	Respondents
100	31
20	26
50	20
200	13
10	12
40	11
5	9
30	8
1	7
2	5
80	3
4	2
8	2
15	2
365	2
500	2

Regarding the second question of “How do you develop your IT skills in your workplace?”, three answer options were inquired: training opportunities, learning through practice and/or in some other way. The total number of responses of 280 were distributed as shown on Table 11. In case of the sectors, 214 out of 242 respondents (88,4 %) in private sector and 33 out of 37 (89,2 %) in public sector responded. While “In some other way” scored the lowest in numbers, several respondents provided detailed descriptions on the methods used.

Table 11. The distribution of the responses to question "How do you develop your IT skills in your workplace?".

	n	Percent
Training opportunities, for example	167	59,6 %
Learning through practice, for example	248	88,6 %
In some other way, for example	35	12,5 %

Each option was provided with open-ended text input, which produced following: on training opportunities, the responses defined online like webinars or Teams (11), courses (8), trainings by workplace or hardware/software or other external provider (7), seminars, networks, or in university (3), and certifications (2). Learning through practice mentioned involved: learning in, at, or through work (6), from colleagues and knowledgeable people (2), and via research (1). In some other way mentioned involved: peer-to-peer advice (9), self-study (6), watching online videos or other recordings (4), professional publications and web pages (3), searching online (3), developing designs or building systems (2), participation in courses, webinars, and tutorials (2), testing by trial and error and (2), and program participation as key user.

Next, the matter about areas where IT skills are needed or applied was asked on a proposition basis as shown on Figure 16 with the responses. In overall, a high degree of use of IT skills in workplaces can be seen with combined “completely true” and “to some extent true” answers, which suggests that IT skills are relevant in workplaces to carry out work tasks which can be determined as involving knowledge work (for instance, in searching information or communications). Also, similar response tendency as shown on Table 8 can be seen on Figure 16 on core product/service development, innovation, and internal and external communications, with innovation option scoring the lowest for “completely true” answer after the open-ended “some other activity/activities” option: again, it can be concluded that ITs are used to be on par with competition and to provide services to customers via *de facto* standardized digital channels, for instance. The innovation option as “completely true” was defined in respect to the fields as follows: IT based services/game industry (67,6 %), commerce/service sector (42,9 %), other public

sector (42,1 %), industrial operator (41,0 %), engineering/design/consultancy (29,0 %), other private sector (27,8 %), municipality/government (20%), and healthcare (0).

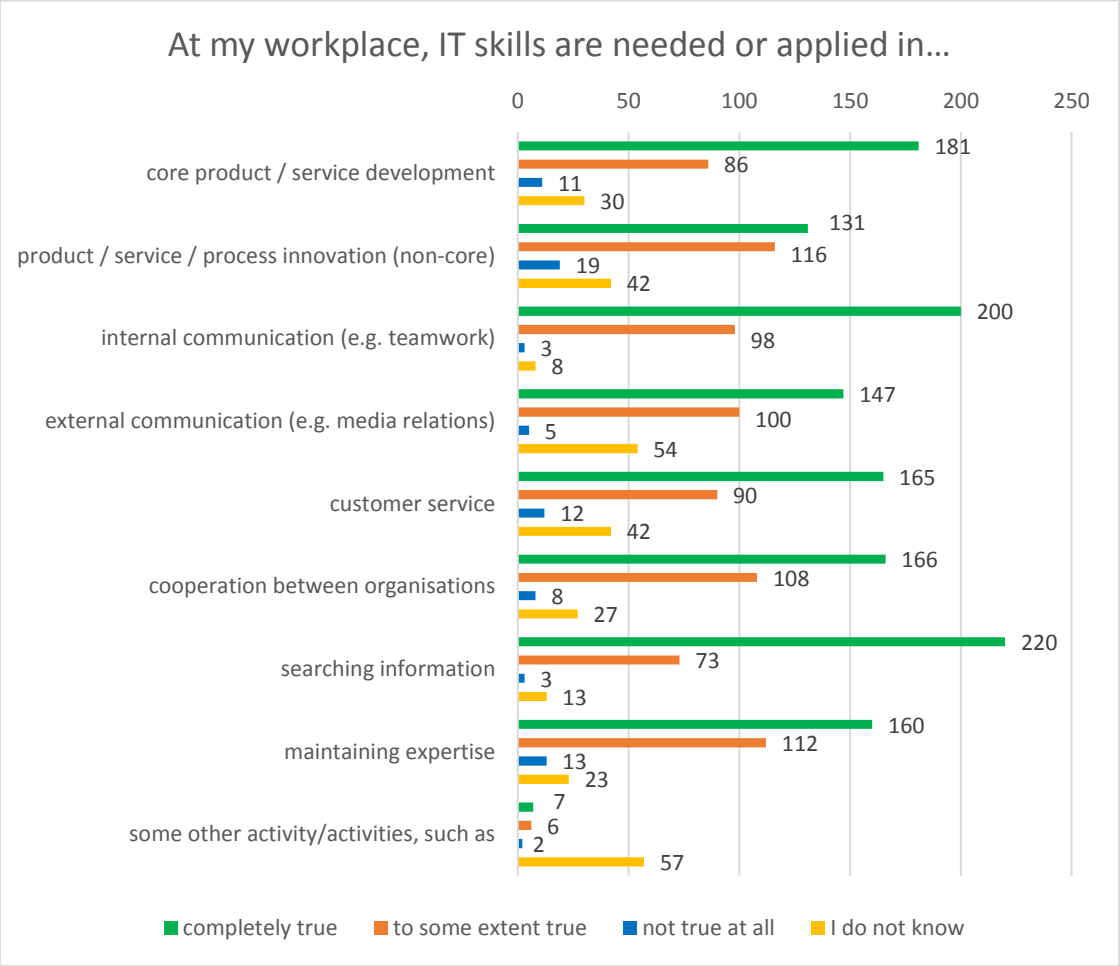

Figure 16. The distribution of the responses to proposition "At my workplace, IT skills are needed or applied in…".

Regarding the open-ended option on some other activity/activities, the produced answers included in all or almost all tasks, financial management, and data/information management handling and analysis.

Next, the acquisition of IT skills in workplaces was inquired, which results are shown on Table 12. In overall, organizations place emphasis on personnel development and acquisition over organizational approaches including cooperation, mergers and acquisitions, and founding subsidiaries, which suggests that IT skills are primarily seen as human-

based resources, which was further confirmed by the open-ended responses on “some other way, for example”.

Table 12. The distribution of the responses to proposition “At my workplace, IT skills are acquired by/via..”.

	n	Percent
training personnel	234	81,0 %
recruiting skilled personnel	195	67,5 %
cooperation between organizations (e.g. transfer or exchange of knowledge or skills)	143	49,5 %
mergers and acquisitions of other organizations	45	15,6 %
establishing subsidiaries geographically closer to skilled experts	19	6,6 %
some other way, for example	25	8,7 %

Regarding the open-ended option, the answers included self-studying (10) during work or spare time, as based on personal enthusiasm and workplace expectations. Others defined peer-to-peer teaching (2), by subcontracting, or via new recruits (3) or information sharing in workshops or sessions (1). Also, the use of IT is expected via using applications or “extra tasks besides (main/core) work”. Interestingly, 3 answers stated nothing or “no need”.

4.1.5 IT in workplaces during the COVID-19 pandemic

As indicated in the section 2.3.3, impacts of COVID-19 in workplaces have varied across industries, with the major theme being the digitalization of work primarily to enable IT-based remote work. Accordingly, examining the matter was relevant to understand how the pandemic has shaped work according to the knowledge work professionals in Finnish workplaces. First, the proposition about the impacts was inquired with options and responses (273 in total) on Table 13.

Table 13. The distribution of the responses to proposition “During COVID-19, at my workplace...”.

	n	Percent
IT rollout projects have been re-prioritized, for example	39	14,3 %
new IT rollout projects have been started	123	45,1 %
existing IT has been more widely adopted or its use encouraged (e.g. innovation, communication)	212	77,7 %
personnel's IT competences have been developed or development encouraged	142	52,0 %
IT has been impacted in some other way, for example	11	4,0 %

The open-ended answers on reprioritization of IT rollout projects included remote work (15), and acquisition of equipment and systems for home office (3). Also, some projects have been rescheduled, reshaped or cancelled (5). Regarding other impacts, “capacity and security of information networks have become priority number one” and “hardware base has been renewed”. These answers reflect the impacts more broadly than purely IT project reprioritization. The answers to the option of “existing IT has been more widely adopted or it's use encouraged” were distributed across different workplaces, which suggests that digital tools have become mainstream during the COVID-19. For the option on IT’s impact in some other way, the answers defined increasingly shifting to remote work (8) and use of offered equipment for home office, underlining the previously identified major theme on remote work further.

The final part involving statement of “Use of IT during COVID-19 has (not) improved work productivity because...” gained 125 open-ended input responses. Most of the answers (72) involved remote work in one form or another, as shown on Figures 17 and 18.

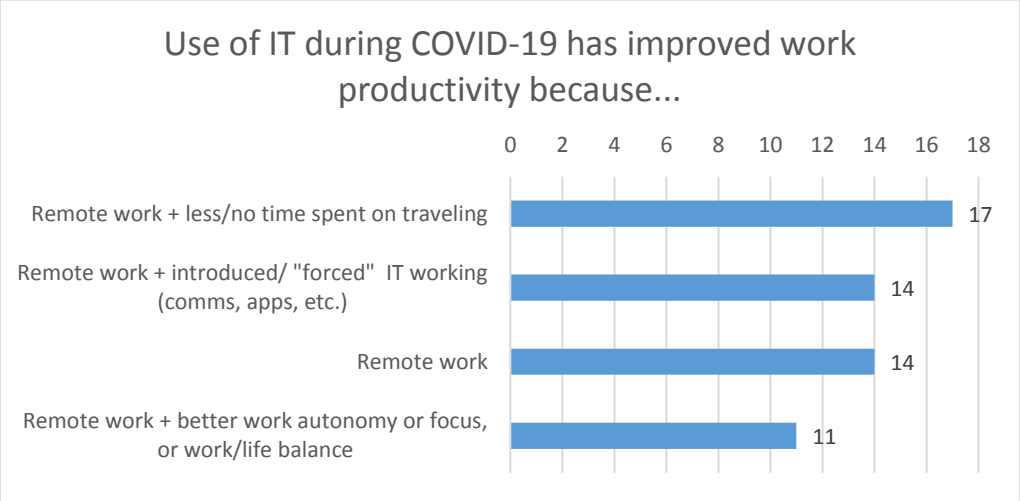

Figure 17. The distribution of the responses on improved productivity by IT during the COVID-19 pandemic.

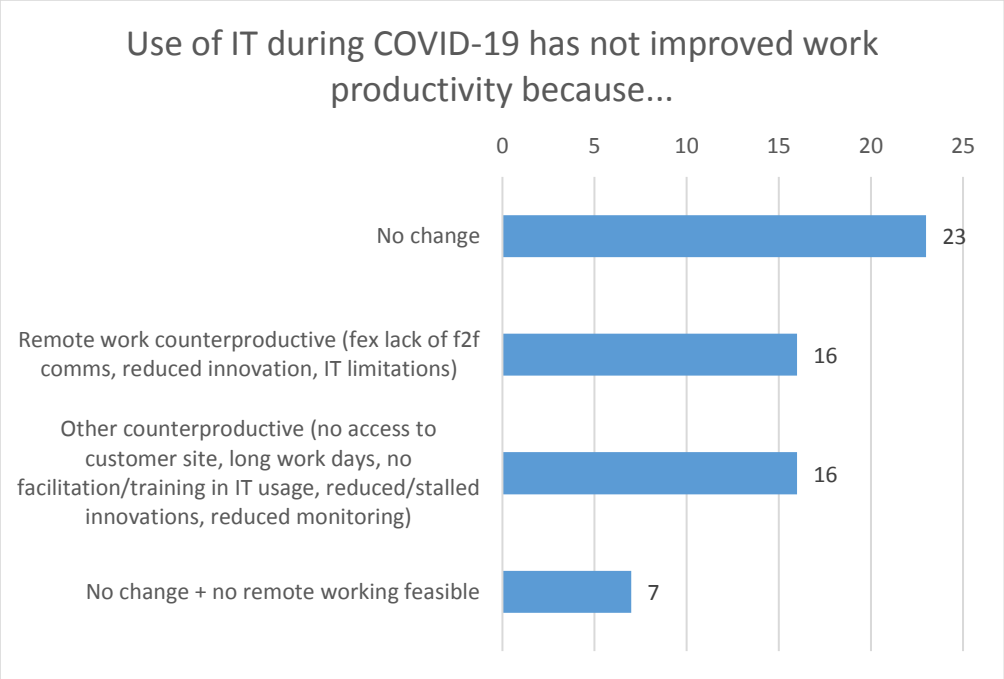

Figure 18. The distribution of the responses on not improved productivity by IT during the COVID-19 pandemic.

According to the responses, productivity had ”improved as travelling has reduced and .. more customer meetings can be arranged per day”. Remote work was seen as increasing work efficiency (7), for example, due to software integration across end-devices. Work time was raised too: while “the basic work has been done by computer, remote work left travelling out, hence work is taking less time“, “remote work has enabled…better

management of work time", and "enabled by remote work, … (spared) time has been sustained … for recovery". Others responded that productivity had not improved or been affected because work methods has been already in use (before COVID), no change had been identified (6), or production requires on-site presence (2). Also, remote work was seen as counterproductive as the quality of interactions had reduced due to electronic communications, "meetings with colleagues are inhibited", and "inefficient meetings and slow flow of information have reduced productivity". Indirect answers indicated limitations of IT in enabling work productivity due to challenges in adoption and using ITs with varied skills (5): for instance, according to comments "it has not improved productivity because working 14-15 hours a day is tiring and not motivating", "number of programs has grown too large", and introduction of ITs has not been led or facilitated for personnel to make the shift, leading to fragmented ways of use. Remote work limited on-site access, resulting in recreation of work situations via online means instead of thinking digitally first, and "it requires more material because people do not show up on-site to see the problem, but try to solve it remotely". Other responses stated that productivity is difficult to determine, and "the same work has to be done as before, and it depends on the customers what kind of work it will be. I cannot say whether productivity has improved, but I believe it has not gone worse".

Some outlined pros and cons: "One can focus better on work since amount of disturbances has been reduced. On the other hand, innovation has been reduced due to complete lack of random encounters", "basic work is done (even better) remotely, but ideation, innovation, and new openings require…presence, discussion, and exchange of thoughts", and "more efficient work time, no time spent on travelling. Communality may have impaired though". Also, productivity "has improved due to remote work. Has not improved, as days are…fully booked for Teams, so breaks are not as often held as in (on-site) office". Similarly, "has improved since…work has continued pretty much like…before COVID…due to…good communication and using same applications at home….Some work tasks…cannot be done remotely, like product testing of physical products".

4.1.6 Work productivity of IT in workplace

The final questions of the questionnaire covered aspects on IT and work productivity in workplaces: performance-based monitoring, the impact of IT and methods on work productivity and costs, and other factors according to the respondents. The first question asked “Does your workplace monitor performance (e.g. indicators) of IT and/or methods?”. Distribution of 310 responses is shown on Table 14. The question was to provide insights on how IT and methods are measured to ensure that their productivity (or lack of it), for instance, can be determined in a tangible manner.

Table 14. The distribution of the responses to question “Does your workplace monitor performance (e.g. indicators) of IT and/or methods?”.

	n	Percent
Yes, for example	66	21,3 %
No, because	59	19,0 %
I do not know	185	59,7 %

Based on Table 14, around 60 % of the respondents do not know whether any performance monitoring of ITs and/or methods takes place in the workplaces. The “Yes” and “No” answers provided open-ended responses with themes as follows:

In case of “Yes, for example” (see Figure 19), 3 respondents defined surveys and questionnaires. Time-based follow-up included fixing times, time per action, downtime in projects and having timetables. 16 answers defined process monitoring, application performance, standby rate, data correctness, servers, system and database functionality, memory storage availability, device usability, information security, and use of test automation in determining quality of continuous integration and solution delivery. Measures or methods used covered tools like Jira, HR performs, quarterly reviews and yearly reports, and 24/7 dashboards, and measures included project KPIs, number of reclamations and productions, delivered story points and registered bugs, and invoicing rate.

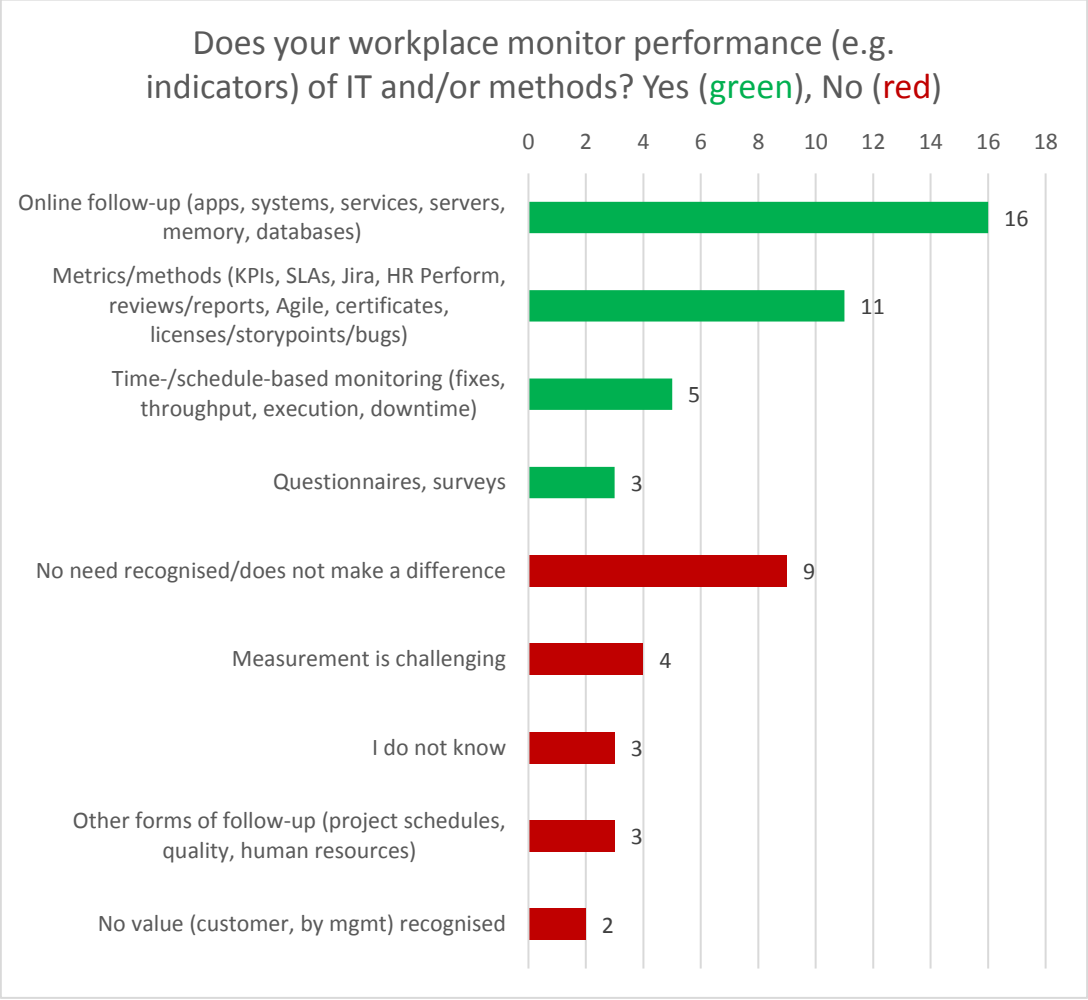

Figure 19. The distribution of "Yes" and "No" answers to the question of performance monitoring.

In case of "No" answers (see Figure 19), most answers (9) defined that need for the measurements has not been recognized: one respondent defined that "functions have been digitalized a long time ago, so self-evident use does not need to be measured", while other outlined on organizational specifics that "small company, no need recognized, maybe cannot be utilized". Others defined that "monitoring has been jointly determined as useless", "we do not measure anything anyway", and "it is not industry standard in the games business". 4 answers defined measuring as difficult, including "project schedules and quality were defined as most important measurements for design work and programming". 2 defined "no time" and "no resources, and monitoring has been jointly recognized as useless". 2 value related answers concluded "executive

team does not see value" and "it does not give any additional value to customers". Priority on human resources was defined by "we trust in people", while business environment was reflected by "due to competition, the highest level of performance already exists". 3 answers defined that "I do not know" including "I do not know, maybe older folks are against it".

The next question "Has introduction of IT and/or methods increased work productivity in your workplace?" produced 309 responses, which distribution is shown on Table 15.

Table 15. The distribution of the responses to question "Has introduction of IT increased work productivity in your workplace?".

	n	Percent
Yes, for example	121	39,2 %
No, because	32	10,3 %
I do not know	156	50,5 %

The "Yes" and "No" answers (see Figure 20) provided following open-ended responses: In case of "Yes", 23 respondents outlined remote or place-independent work due to less time spent on travelling and more work done at home during the time, and also reduced personnel costs. Information was defined including easier, faster and real-time search and access (7), electronic data forms and more data-based analyses, as well as information sharing via cloud services. Automation such as transforming from manual to automated or robotized work (2) and using automated reports, as well as communication improvements, efficient ways internally across organization and in having more meetings quickly (3) was defined. Answers to work task productivity included centralized documentation, 3D modelling, evolving design applications, easier language translation, writing notes and using Excel in calculations. 3 respondents outlined the everyday importance of IT: "IT is part of our industry and without it there is no productivity", "work cannot be done without IT", and "IT has been used for over 30 years, which has certainly made working more efficient compared to doing everything using pen and paper".

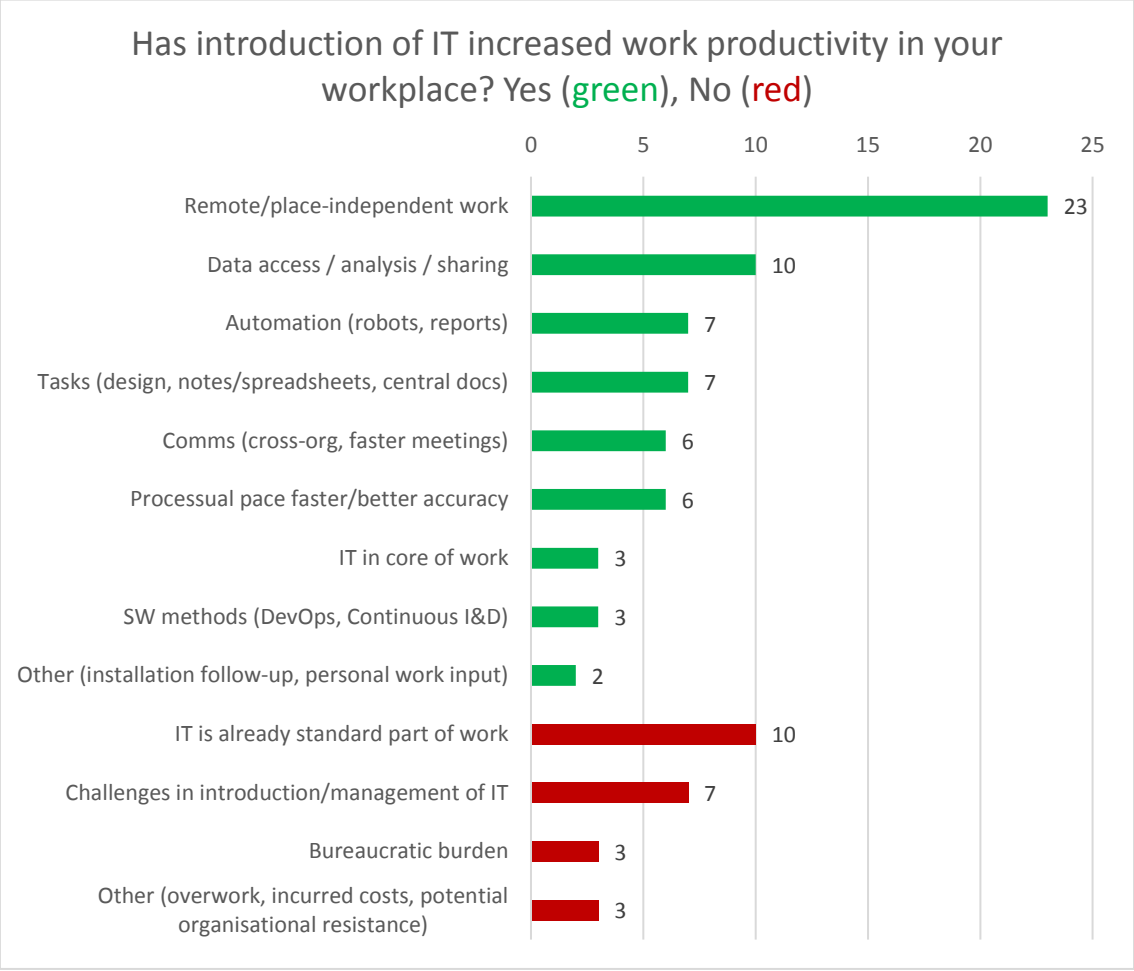

Figure 20. The distribution of "Yes" and "No" answers on the question of increased productivity by IT.

For the "No" answers, 10 respondents defined the standard nature of IT: for example, "IT has not been introduced, it has been always in use", "it has been part of business since founding", "leveraging IT is indispensable part of business", "all work has already been done digitally", and "IT has been used 'always'". 7 answers reflected IT-related challenges: "introduction is badly prepared and managed", "slows down work", "increasing amount of systems is causing confusion", "feasibility of new technologies is not evaluated beforehand, and new applications are constantly tangled with", and "new applications do not function or their adoption is not internalized". Side work tasks involving IT seem to shift focus away from main work: "producing reports, actual work is side matter", "correcting errors and bureaucracy consume most of the time", and "there exists more

work than one can bear". Also, organizational resistance may exist according to the comment on "old guard is against it".

The question on "Has introduction of IT and/or methods increased costs in your workplace?" produced 309 responses which shares are shown on Table 16.

Table 16. The distribution of the responses to question "Has introduction of IT increased costs in your workplace?".

	n	Percent
Yes, for example	81	26,2 %
No	57	18,5 %
I do not know	171	55,3 %

The "Yes" answers included open-ended responses (see Figure 21): IT investments (17 responses), licences (16 responses), and hardware and system updates, for instance, in enabling remote work, network connectivity, and ensuring that hardware runs software (9 respondents). 2 respondents defined work efforts and errors due to system overlaps. Also raised were downtime, shift from on-site visits to remote work, ERP, training and change-related disturbances, "new ways of working increase costs", and "getting data out and analysis require technology and resources". A respondent stated "good tools cost but will pay back when used properly (right tool for each problem/challenge)".

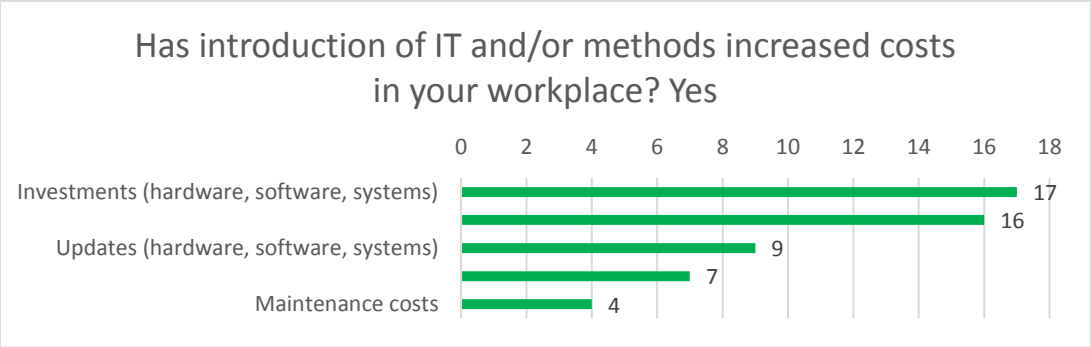

Figure 21. The distribution of "Yes" answers on the question of increased costs.

The final question of “What other factors have influenced development of your work productivity?” produced 48 answers which categorized themes are shown on Figure 22.

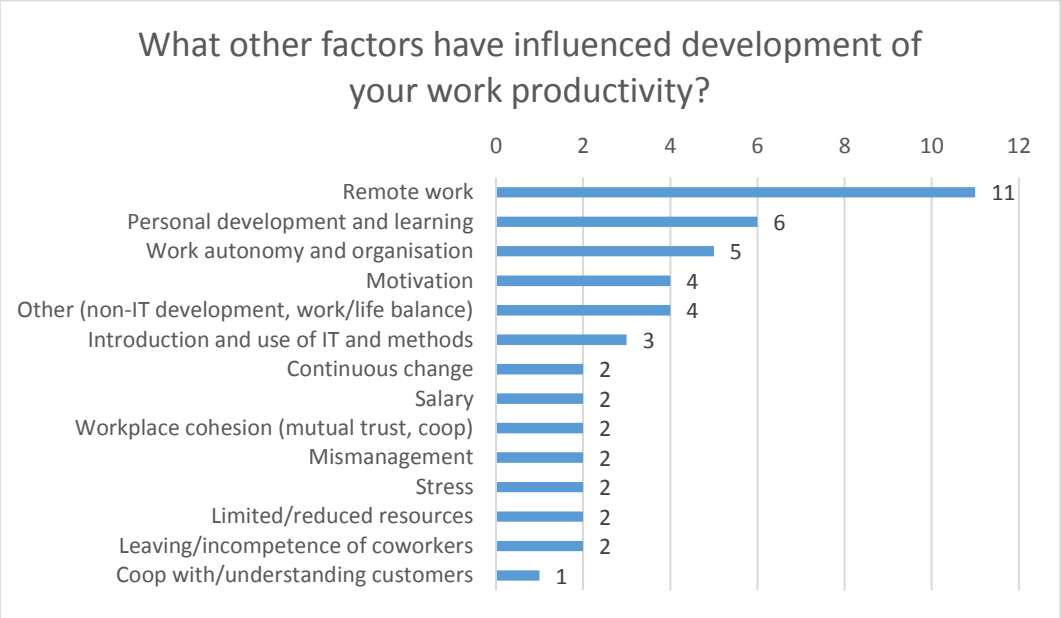

Figure 22. The distribution of the responses on other factors influencing development of work productivity.

Remote work was raised in good and bad: “functioning Teams”, and fewer distractions and wasting time in travelling were identified, yet “reduced F2F communication has made work less enjoyable”, and remote work has made having breaks difficult, “raising productivity first, then backfired due to immobility, for instance, and hence productivity reduced”. Personal development was defined including "using freed time for self-study", "learning new systems", "development of personal competences and processes", and “personal motivation to learn new". Importance of having control over personal work or work autonomy aspects underlined proactivity, opportunity for organization and focus by oneself, and work privacy were defined as well as “flexibility allows you to work at the best time for your own productivity”. Motivational factors varied: "new normal i.e. constant change reduces … motivation and productivity", and "constant changes in tools and process changes slow down and reduce motivation to learn new", while ”functioning devices and applications maintain (good) work motivation”. Workplace factors included “big resignation…key people leaving”, "management is unaware what designers are

doing, what doing work is required and how IT could be made more efficient by developing operating models", and "mutual trust between employer and employee, and good workplace atmosphere". Work-life balance was reflected by “sound use of free time (exercising, hobbies and friends) which increases well-being”. 2 respondents highlighted "short of resources, tight schedules, empty treasury" and "tightening resources initially boosted productivity, but exhaustion is rapidly taking productivity down". Productivity without compensation was defined by “I have to stretch practically every day to work longer than 7,5 hours, so my employer receives at least 10 hours of free work a week from me”. One reflected “developments in practices and tools other than changes in IT”, while introduction and use of IT and methods was defined with “our new ERP project is going awry and being delayed” and “computer aided design has improved productivity and quality, but on the other hand development and maintenance of systems requires lots of resources.” Other outlined that “productivity development has been positive, but on the other hand, other increased work has eaten away this benefit”.

4.2 Workplace context factors in respect to increased productivity, performance monitoring and costs of IT

The responses to the questions on work productivity of IT in workplaces raised interest for further analysis due to several respects. In particular, as shown on Tables 14, 15 and 16, most answers were given to the “I do not know” option. What factors might explain the answers? Also, according to the responses the work productivity had improved as result of the introduction of IT (Yes: 39,2 %), while number of responses almost halved on monitoring the performance of IT and/or methods in workplace (Yes: 21,3 %), which seems conflicting: how is the productivity improvement determined, if the performance monitoring is not applied? Given the findings about contextual specifics in the previous subsections, what kind of differences might explain the asymmetric responses to the work productivity questions? To draw further insights, descriptive statistical analysis using crosstabulation was carried out as follows: increased productivity and performance monitoring in respect to each other and digitalization strategy, increased productivity

and performance monitoring in contexts of employments and workplace sectors, increased costs in respect to the employments and sectors, and increased productivity and performance monitoring in selected workplace organization contexts.

4.2.1 Increased productivity and performance monitoring in respect to each other and digitalization in organizational strategy

The results of the two questions of “Has introduction of IT and/or methods increased work productivity in your workplace?” and “Does your workplace monitor performance of IT and/or methods?” were crosstabulated to see how the answers are distributed across in respect to each other and the question on digitalization as part of organizational strategy. Unless otherwise defined, the term of “the two questions” is used on them next for brevity.

The results on Table 17 show that workplaces where the monitoring is done (“Yes”) together with recognized increased productivity (“Yes”) have the highest number over the other productivity options (“No”, “I do not know”) on the increased productivity. In case of no monitoring (“No”), the combination with “Yes” answers on the productivity shows the highest number (51,7 %), even if other answer options on the productivity were combined (48,3 %), and the “I do not know” answers to the two questions show up with the highest relative (and absolute) number. Almost 1/4 of the answers recognized increased productivity (“Yes”) without awareness on the performance monitoring (“I do not know”). The outcomes indicate that determining, perceiving or awareness in some other form of the increased productivity than by the performance monitoring is taking place in the workplaces or individual work of the respondents.

Table 17. The results of the crosstabulated responses of the two questions on increased work productivity and performance monitoring.

		Performance monitoring?			
		Yes	No	I do not know	Total
Increased work productivity?	Yes	45	30	46	121
		70,3 %	51,7 %	24,9 %	39,4 %
	No	2	17	13	32
		3,1 %	29,3 %	7,0 %	10,4 %
	I do not know	17	11	126	154
		26,6 %	19,0 %	68,1 %	50,2 %
	Total	64	58	185	307
		100 %	100 %	100 %	100 %

Next, the answers of the question of “Has your workplace outlined digitalization in organizational strategy?” were reflected with the two questions. The results on Table 18 demonstrate that the numbers to the three “Yes” answers indicate about the relation of digitalization as part of the strategy, performance monitoring and increased productivity, while on the other hand confirming the previously founded claim that in overall the performance monitoring is not universally applied or related in determining the productivity impact. Again, the high numbers of “I do not know” answers across the table indicate unawareness, even regardless of the answers on digitalization in the strategy: this may suggest that the importance of digitalization in certain workplaces has been acknowledged without determining its tangible impact on productivity or involving performance monitoring of IT as for awareness in these areas by the respondents is concerned. Also, digitalization may have been recognized as mainstream development in internal and external contexts (e.g., competition) and hence the organizational focus has been defined for now on intentional level and set-up stage for later tangible development activities.

Table 18. The results of the crosstabulated responses of the two questions in respect to the question on digitalization in organizational strategy.

		Performance monitoring?			
Digitalization in org. strategy?	*Increased productivity?*	Yes	No	I do not know	Total
Yes	Yes	41	11	30	82
		74,5 %	55,0 %	30,3 %	47,1 %
	No	1	5	5	11
		1,8 %	25,0 %	5,1 %	6,3 %
	I do not know	13	4	64	81
		23,6 %	20,0 %	64,6 %	46,6 %
	Total	55	20	99	174
		100 %	100 %	100 %	100 %
No	Yes	3	13	5	21
		75,0 %	54,2 %	22,7 %	42,0 %
	No	1	6	3	10
		25,0 %	25,0 %	13,6 %	20,0 %
	I do not know	0	5	14	19
		0,0 %	20,8 %	63,6 %	38,0 %
	Total	4	24	22	50
		100 %	100 %	100 %	100 %
I do not know	Yes	1	6	11	18
		20,0 %	42,9 %	17,5 %	22,0 %
	No	0	6	5	11
		0,0 %	42,9 %	7,9 %	13,4 %
	I do not know	4	2	47	53
		80,0 %	14,3 %	74,6 %	64,6 %
	Total	5	14	63	82
		100 %	100 %	100 %	100 %

4.2.2 Increased productivity and performance monitoring in respect to professional roles and workplace sectors

Next, the professional roles and workplace sectors were reflected in respect to the two questions. As shown on Table 19, the managerial respondents recognized more often the impact of increased productivity (“Yes” answers under Total column) than the specialists who also reported over 50 % of unawareness (“I do not know” answers under Total column), i.e., almost 10 % more than the managers; also, the specialists reported the highest number of “I do not know” answers to the questions in relative and absolute numbers, underlining unawareness on the increased productivity and performance monitoring. Still, the rates of “Yes” answers to the two questions in both professional

roles are relatively high in respect to the other answers options, which may suggest that awareness on the performance monitoring and increased productivity has a linkage, i.e., the follow-up of IT performance has been used in validating the increased productivity of IT.

Table 19. The results of the crosstabulated responses of the two questions in respect to the professional roles.

		Performance monitoring?			
Professional roles	*Increased work productivity?*	Yes	No	I do not know	Total
Managerial role	Yes	16	13	15	44
		72,7 %	50,0 %	31,3 %	45,8 %
	No	1	7	2	10
		4,5 %	26,9 %	4,2 %	10,4 %
	I do not know	5	6	31	42
		22,7 %	23,1 %	64,6 %	43,8 %
	Total	22	26	48	96
		100 %	100 %	100 %	100 %
Specialist role	Yes	29	17	31	77
		69,0 %	53,1 %	22,8 %	36,7 %
	No	1	10	11	22
		2,4 %	31,3 %	8,1 %	10,5 %
	I do not know	12	5	94	111
		28,6 %	15,6 %	69,1 %	52,9 %
	Total	42	32	136	210
		100 %	100 %	100 %	100 %

Adding the workplace sector revealed further differences as shown on Table 20: for instance, awareness in managerial roles appears as opposite as the number of both “Yes” and “No” answers to the increased productivity by the public sector managers are lacking, which is underlined as the managers in the private sector recognized the increased productivity with 50,0 % “Yes” answers under Total column. Also, the disparity is highlighted as the specialists in the public sector responded with “Yes” and “No” answers on increased productivity. Based on these findings, it seems that the managers in the private sector are mostly informed or aware about the increased productivity, also in respect to the specialists in both sectors, while the management in the public sector is not aware of productivity development or performance monitoring of IT in workplaces.

Table 20. The results of the crosstabulated responses of the two questions in respect to the professional roles and workplace sectors.

			Performance monitoring?			
Workplace sector	*Professional roles*	*Increased work productivity?*	Yes	No	I do not know	Total
Private sector	Managerial role	Yes	16	13	15	44
			72,7 %	52,0 %	36,6 %	50,0 %
		No	1	7	2	10
			4,5 %	28,0 %	4,9 %	11,4 %
		I do not know	5	5	24	34
			22,7 %	20,0 %	58,5 %	38,6 %
		Total	22	25	41	88
			100 %	100 %	100 %	100 %
	Specialist role	Yes	26	13	27	66
			70,3 %	52,0 %	23,1 %	36,9 %
		No	1	8	11	20
			2,7 %	32,0 %	9,4 %	11,2 %
		I do not know	10	4	79	93
			27,0 %	16,0 %	67,5 %	52,0 %
		Total	37	25	117	179
			100 %	100 %	100 %	100 %
Public sector	Managerial role	I do not know		1	7	8
				100 %	100 %	100 %
		Total		1	7	8
				100 %	100 %	100 %
	Specialist role	Yes	3	4	4	11
			60,0 %	57,1 %	21,1 %	35,5 %
		No	0	2	0	2
			0,0 %	28,6 %	0,0 %	6,5 %
		I do not know	2	1	15	18
			40,0 %	14,3 %	78,9 %	58,1 %
		Total	5	7	19	31
			100 %	100 %	100 %	100 %

Next, the results of the question “Which of the following describes the field of your current workplace?” were reflected on workplace organization specifics for analysis. Due to size of the result tables, summary of the results shown in appendix 2 is covered here as follows: in most workplaces, the largest absolute numbers involved having both the two questions with the “I do not know” answer. The only difference was commerce or other service sector, where answers of “Yes” on increased productivity and “No” to

performance monitoring totalled (28,6 %); also, all “Yes” answers on increased productivity totalled first (57,1 %) over “I do not know” (14,3 %), while in other fields “I do not know” overcame “Yes” answers for the same. It should be noted though that while the results suggest field specific differences in digitalization, the total number of answers in many fields was somewhat low, which leaves doubt about comprehensiveness of the results.

Finally, comparison of combinations of “Yes” and “Yes” answers and “I do not know” and “I do not know” answers to the two questions was done to reflect the extremes in the related awareness, also because the workplace fields had the data available in numbers greater than 0, hence enabling the reflection. Accordingly, the highest relative differences between the combinations were as follows (“I do not know” answers divided by “Yes” answers): municipality, association of municipalities or government/state (12/1 = 12 times), other in public sector (10 / 2 = 5 times), engineering/design/consultancy (24 / 7 = 3,4 times), industrial operators (44 / 16 = 2,8 times), other in private sector (5 / 2 = 2,5 times), commerce or other service sector (2 / 1 = 2 times), healthcare (2 / 1 = 2 times), and IT based services or game industry (26 / 15 = 1,7 times).

The results suggest that awareness on the increased productivity of introduced IT and performance monitoring is greater in certain types of workplaces than others, more specifically less so in public sector than in private sector fields perceived as technology-intensive including IT based services or game industry, industrial operator, and engineering/design/consultancy. While performance monitoring is strongly associated particularly in light of the “Yes” answer to the two questions, which suggests that the monitoring is used in determining the increased productivity of introduced IT, this is not the case in all workplaces. Instead, increased productivity has been recognized in other ways than by using performance monitoring specifically.

4.2.3 Increased costs in respect to professional roles and workplace sectors

Given the employment and sector specific results over the increased work productivity and performance monitoring, further analysis was carried out on the increased IT costs by reflecting answers to the question of “Has introduction of IT increased costs in your workplace?” involving the defined categories. The results on Table 21 demonstrate differences in respect to the results of Table 20: most of the public sector managers (4) recognized (“Yes”) the incurred costs over other options (2, “No”; 2, “I do not know”). In relative terms, “Yes” answers were the highest single most result, as in other roles in both sectors the numbers of “I do not know” answer were the highest, followed by the numbers of “Yes” answers. It seems that the public sector managers focus on the cost side of IT only, while the private sector managers have awareness on both costs and increased work productivity (“Yes” answers), potentially involving use of methods such as cost and benefit ratio for the purpose.

Table 21. The results of the crosstabulated responses of the two questions in respect to increased costs, professional roles and workplace sectors.

			Increased costs?			
Workplace sector	*Professional roles*	*Increased work productivity?*	Yes	No	I do not know	Total
Private sector	Managerial role	Yes	20	13	10	43
			64,5 %	61,9 %	27,8 %	48,9 %
		No	4	5	1	10
			12,9 %	23,8 %	2,8 %	11,4 %
		I do not know	7	3	25	35
			22,6 %	14,3 %	69,4 %	39,8 %
		Total	31	21	36	88
			100 %	100 %	100 %	100 %
	Specialist role	Yes	20	16	30	66
			52,6 %	57,1 %	26,5 %	36,9 %
		No	4	7	9	20
			10,5 %	25,0 %	8,0 %	11,2 %
		I do not know	14	5	74	93
			36,8 %	17,9 %	65,5 %	52,0 %
		Total	38	28	113	179
			100 %	100 %	100 %	100 %
Public sector	Managerial role	I do not know	4	2	2	8
			100 %	100 %	100 %	100 %
		Total	4	2	2	8
			100 %	100 %	100 %	100 %
	Specialist role	Yes	4	2	5	11
			57,1 %	40,0 %	26,3 %	35,5 %
		No	0	2	0	2
			0,0 %	40,0 %	0,0 %	6,5 %
		I do not know	3	1	14	18
			42,9 %	20,0 %	73,7 %	58,1 %
		Total	7	5	19	31
			100 %	100 %	100 %	100 %

Based on the results, the productivity and cost impact of IT and the performance monitoring are perceived differently: the increased productivity (“Yes”) is recognized by the managers in the private sector, whereas such awareness exists less in the public sector among the managers. Same applies in case of the performance monitoring. Instead, the cost impact is recognized by the managers in both sectors. The results suggest in the private sector the use of IT and related methods is followed more often with productivity improvement in mind and involving also performance monitoring. In the public sector,

the management does not conduct such follow-up, suggesting that the use of IT is not tied to any high-level productivity goals. In case of the private sector, the follow-up by the managers is highlighted also in respect to the high number of unawareness ("I do not know") by the specialists, whereas conversely in public sector the specialists appear to have better awareness of the productivity impact: as indicated earlier, the follow-up on the improvement appears to be based on subjective perception instead of using any particular measurement. The findings also seem to confirm the previously established challenges of the public sector as for measuring productivity of IT is concerned.

4.2.4 Increased productivity and performance monitoring in selected workplace organization contexts

Next, contexts involving Finnish and foreign workplace organizations were reflected with the two questions to see whether the factors could introduce differences over the areas:

Is your workplace a foreign-owned (over 50 %) company?
Has introduction of IT increased work productivity in your workplace?
Does your workplace monitor performance of IT and/or methods?

Table 22 demonstrates following findings: first, foreign-owned companies which exercise performance monitoring ("Yes") acknowledged also increased productivity ("Yes") over the other responses ("No", "I do not know"). The distinction between foreign-owned and non-foreign owned companies/organizations is interesting: first, the foreign-owned companies with the "Yes" answers on performance monitoring show up with zero "No" answers on increased productivity. While "No" answers on increased productivity in other options of performance monitoring are not high either, the total of zero "No" answers in comparison with the "Yes" answers raises interest on the influencing specifics. While the similar distribution of answers can be seen across non-foreign companies/organizations which conduct performance monitoring ("Yes"), the numbers of "No" answers on performance monitoring are relatively higher. of the two company categories. The results suggest that foreign-owned companies may have more coherent approach

on determining IT-based productivity and involving the performance monitoring as an integral part of the follow-up, analysis, and consequent development and other actions taken as required based on the acquired data.

Table 22. The results of the crosstabulated responses of the two questions in respect to the question on workplace ownership.

		Performance monitoring?			
Workplace foreign-owned (>50 %)?	*Increased work productivity?*	Yes	No	I do not know	Total
Yes	Yes	24	5	17	46
		77,4 %	45,5 %	28,8 %	45,5 %
	No	0	4	6	10
		0,0 %	36,4 %	10,2 %	9,9 %
	I do not know	7	2	36	45
		22,6 %	18,2 %	61,0 %	44,6 %
	Total	31	11	59	101
		100 %	100 %	100 %	100 %
No	Yes	21	25	29	75
		63,6 %	53,2 %	23,2 %	36,6 %
	No	2	13	7	22
		6,1 %	27,7 %	5,6 %	10,7 %
	I do not know	10	9	89	108
		30,3 %	19,1 %	71,2 %	52,7 %
	Total	33	47	125	205
		100 %	100 %	100 %	100 %

Based on the previous results, large number of the respondents in public sector organizations is particularly presented in the “I do not know” answers, which influence can be seen on Table 22 as well. The relation of the “Yes” and “I do not know” answers to the two questions demonstrates that in case of foreign-owned companies the rate is 1,5 times while in case of non-foreign owned companies/organizations it is almost 2,5 times. Interestingly, when the public sector was removed from the total numbers by using select cases function with IBM SPSS (if Workplace_sector ~= 2, as 2 was coded with public sector label), the removed answers made the relation even wider with result of 3,7 times:

in other words, the non-foreign (private) organizations seem to have even higher disparity among the extremes of the “Yes” and “I do not know” answers, reflecting greater lack of the awareness. Moreover, as Table 23 demonstrates, disparities between the foreign-owned and non-foreign owned companies, in particular across “No” answers on performance monitoring are distinctive as the latter ones have higher absolute number in overall, as well as between “Yes” and “No” answers on performance monitoring within each company categories. The results suggest that foreign-owned companies may have more coherent approach on determining IT-based productivity and involving the performance monitoring as an integral part of the follow-up, and consequent development and other actions based on the acquired and analysed data.

Table 23. The results of the crosstabulated responses of the two questions in respect to privately owned workplace organizations (i.e., public sector organizations removed from the data).

		Performance monitoring?			
Workplace foreign-owned (>50 %)?	*Increased work productivity?*	Yes	No	I do not know	Total
Yes	Yes	24	5	17	46
		77,4 %	45,5 %	28,8 %	45,5 %
	No	0	4	6	10
		0,0 %	36,4 %	10,2 %	9,9 %
	I do not know	7	2	36	45
		22,6 %	18,2 %	61,0 %	44,6 %
	Total	31	11	59	101
		100 %	100 %	100 %	100 %
No	Yes	18	21	25	64
		64,3 %	53,8 %	25,5 %	38,8 %
	No	2	11	7	20
		7,1 %	28,2 %	7,1 %	12,1 %
	I do not know	8	7	66	81
		28,6 %	17,9 %	67,3 %	49,1 %
	Total	28	39	98	165
		100 %	100 %	100 %	100 %

5 Discussion and conclusions

The research focus of this thesis was the productivity of IT in Finnish workplace organizations as perceived by knowledge work professionals. The research was started with review of international and Finnish researches on the productivity paradox, introduction of knowledge work in respect to work productivity and involving increased use of IT in the work, and description of the impacts of the COVID-19 pandemic in the work. The empirical part involved quantitative and qualitative mixed method analysis of primary data which was gathered in form of the responses to questionnaire which was sent the selected group of knowledge work professionals, that is, the members of the Union of Professional Engineers in Finland. The questionnaire included 29 questions on personal and workplace background, utilization of IT in workplaces, IT skills and training, IT in workplaces during COVID-19, and work productivity of IT in workplaces. Besides differences and aligned themes found from the results, the follow-up analyses indicated that the relation of IT used in work and work productivity in Finnish workplaces is understood and perceived differently depending on the professional role (managerial or specialist), the field of workplace, the sector (private or public), and domestic or foreign ownership of the workplace organization.

5.1 Impacts of IT in Finnish workplaces according to knowledge work professionals

Regarding the first research question “What impacts in the use of IT in Finnish workplaces have been identified by knowledge of work professionals?”, analyses over the responses introduced following insights:

Based on the experiences by the respondents, certain answers indicated that IT propagates transformational effects and trade-offs, which depending on implementation in workplace may improve some forms or foundational preconditions of work productivity, while also potentially inhibiting materialization of others for the improvement. The

quantitative results indicated that in most workplaces ITs are perceived as impactful in facilitating standardized work processes such as communications, development of core products, services, and processes, and financial management, in particular. The respondents with insights on the aims of digitalization as part of organizational strategy acknowledged the importance in improving productivity, reaching out new markets and/or customer segments, and staying in competition in particular. The trade-off effects were demonstrated in the responses over the use of IT during the COVID-19 pandemic: although the use of IT has increased in enabling carrying out routine work processes remotely, other experiences indicated that the cumulation of IT in form of new systems in addition to existing ones was becoming a burden involving unmanageable change, extra work and hence more work time, instead of facilitating the tasks and increasing work efficiency. Similarly, in some cases tasks which had been previously done by dedicated personnel had been reallocated due to adoption of IT, hence increasing workload. The lack or unavailability of appreciated learning opportunities over IT to curb the learning curve was also indicated as raising threshold in adoption of IT especially during the pandemic, which most likely contributes further with the adverse work results: while many respondents indicated in their answers to the open-ended questions of appreciating increased autonomy in learning new IT, this may not work in case of others who are not familiar with using IT, and who hence require more guided approach by the workplace organization to support their learning. The role of workplace-based IT skills and training opportunities was highlighted in numbers of hours spent in learning at work, hence underlining the importance of workplace-originated skills development and training paths as an effective way of preventing digital divide in work community: based on the responses, this approach apply in particular to the public sector workplaces, where more hours for the skills development is done at work than off-work. The acute need for the skills development with workplace support is nevertheless recognised as a direct impact of the increased introduction of IT in work. As a result of increasing amount of work and hence more work time spent, the described inhibitors or barriers in the use of IT in work were indicated as having implications on work motivation: in light of the theoretical setting by the previous research on the nature of knowledge work, this indicates lack of

management by knowledge workers over the elements of their personal work. The responses on such impacts are aligned with the previous researches about enablers and barriers in the use of IT as part of knowledge work and their implications on the productivity of knowledge work: such inhibitors and barriers may effectively delay or even prevent introduction of the intended benefits of IT, which as an identified potential cause of the productivity paradox is a valid concern.

Besides of the use of IT facilitating with enabler effects and building blocking barriers, an additional interesting result in form of rather neutral answers indicated that the use of IT is standardized part of daily work, without pro or con opinions in one form or another. The responses seemed to be aligned with the research findings which have suggested that IT may not be as revolutionary technology as the technologies of the previous Industrial Revolutions, although such impact may not be the case in all fields of workplaces, sectors or professional roles: as stated previously, the impact of IT in work depends greatly on having appropriate skills by and support of the workplace for the knowledge work professionals to apply and develop their competences in full scale of managing personal work as well as innovating further with IT. Given the responses on the impact of the use of IT in routine work processes rather than in generating innovations, this lead to the following conclusion: as a rule of thumb in such cases, the commonness of IT in form of diffused GPTs may or may not be the cause of lack of increased productivity in case of routine work, whereas lack of leveraging IT in generating further innovation certainly is. After all, besides the enabler or barrier effects of ITs in, for example, doing routine work with consequent productivity outcomes, innovation of new products, services and processes by using technology has been identified by previous researches as a pivotal contributor in generating new productivity growth. While the increased use of IT may have contributed in improving routine work tasks, in particular, based on the experiences and perceptions by the respondents, leveraging innovation potential of IT is less comprehensive: for instance, the wide adoption of certain forms of IT like social media and cloud computing as diffused GPTs indicated such development, whereas the ITs such as big data and artificial intelligence which have been hyped as having potential for

innovative solutions have not been widely adopted in Finnish workplaces for now and beyond of integrated parts of other standardized solutions such as robotic process automation. Although adoption of such diffused GPTs enables the organizations to stay in competition and reach out other technologically-oriented stakeholders like customers and partners, genuine increase in work productivity remains doubtful in case the adoption does not result in differentiation in products, services or processes beyond of their incremental development into digitized forms. In other words, while innovation of new products, services and processes in general may not be among top priorities of the workplaces in using IT, it should nevertheless be on focus when searching ways to increase productivity in Finnish organizations. As a complementary aspect besides focusing on the technological side of innovation, the personal interaction by the employees should be addressed as potential to be capitalized: reduced personal interaction due to replacement of on-site office work to working remotely may inhibit further innovation, as was indicated by many respondents on the impacts of the COVID-19 pandemic.

5.2 Relation of work productivity and use of IT according to knowledge work professionals

Regarding the second research question “How is the relation between work productivity and the use of IT understood or perceived by knowledge work professionals?”, the answers indicated high level of unawareness on the relation among the respondents together with large amount of subjective perceptions of the matter: as a first indicator, the initial analysis of organizational background revealed that while digitalization as part of organizational strategy was recognized by majority of the respondents (“Yes”: 57,8 %), a significant amount of them were not aware of the matter (“I do not know”: 25,7 %) with the fields rating 25 % or more including engineering/design/consultancy, healthcare, municipality/association of municipalicities/government, and IT based services and game industry. The fields where “No” answers rated 20 % or more included commerce/other services, healthcare, and industrial operator. Combining the previous answers suggests unawareness of or lack of digitalization in the strategy particularly in

workplaces which have not been traditionally IT intensive or primarily dependent on IT. The “Yes” answers with rate of 57 % or more included fields of other in private and public sector (particularly involving educational institutions), and IT based services and game industry. The results suggest that the use of IT as part of personal work in respect to strategy-level goals in workplace organizations are not recognized as aligned by all respondents: this was underlined further by the crosstabulated results over the answers to the questions on increased productivity and performance monitoring in respect to the answers to the question on digitalization as part of the strategy, where the two former matters were responded overwhelmingly with “I do not know” answers despite of “Yes” answers on the digitalization as part of the strategy. Another potential cause of the unawareness may be due to professional role-based information asymmetry with sector specifics: based on the findings, it seems that the managers in the private sector are mostly aware about the increased productivity, also in respect to the specialists in both sectors, while members of the management in the public sector are not aware of productivity development or performance monitoring of IT in the workplace. Also, the asymmetry appears to be more typical to larger organizational size with multiple levels and hierarchies, and potentially involving access limitations to the productivity information, which are both matters which may result in difficulty of grasping a holistic overview on the productivity and in respect to personal work.

As for work productivity of IT in workplaces in the final part of the questionnaire, the high number of “Yes” answers the question on improved work productivity in respect to the other answers raised doubts on whether the theme of the questionnaire, which was introduced in the invitation letter as well as in description of the questionnaire form, had guided some respondents to answer ‘as expected’. This indication was underlined further by the questions on the performance monitoring and increased costs which received significantly lower amount of “Yes” answers in absolute and relative numbers in respect to the other answer options. The open-ended answers introduced another potential explanation on the “Yes” answers over the increased productivity: many respondents defined remote work as contributing with several benefits including more time

focused on work instead of travelling, less interruptions and on-site-originated disturbances, and shorter or less breaks. Furthermore, remote work has introduced motivational elements according to certain respondents (e.g., management of personal work, improved focus, better work and life balance), which may have contributed on the perception of increased productivity of personal work. While the trend of remote work has become mainstream in many workplaces as result of the COVID-19 pandemic, these results were aligned with the pre-COVID-19 researches on the relation of knowledge work and IT as well. On the other hand, the defined productivity improvements appeared to be based mainly on subjective perceptions and experiences, which real effectiveness is challenging to be confirmed due to lack of tangible follow-up with measurement on continuous basis (which the answers over the performance monitoring indicated as well).

Finding contextual differences over the second question was partially successfully given the scope of the research. The numbers of the respondents working in the private and public sectors were disproportional in absolute numbers as out of over 320 respondents overwhelming majority of 8/9 represented the private sector, even though this share represents the reality on the IL members according to the information reported by the IL. The main contribution of the sector-specific results related to insights of the differences among the professional roles, which indicates need for conducting further research over the sector specifics: in particular, the differences of awareness on productivity of IT among the managers in the public and private sectors and the emphasis on costs by the managers in the public sector indicates differences on how and from what perspectives IT is perceived and valued in different workplaces. Moreover, further analysis of the workplaces as foreign-owned and non-foreign-owned organizations introduced interesting insights on the alignment of improved productivity of IT and performance monitoring: i.e., foreign-owned companies may have and apply more coherent approach on determining IT-based productivity, that involving the use of the performance monitoring as an integral part of the follow-up, analysis and consequent development and other actions as required.

5.3 Impacts of IT-related enablers and challenges on work productivity and in respect to the productivity paradox

Regarding the final research question “What IT-related enablers and challenges can be identified as impacting on work productivity in workplace organizations (of knowledge work professionals), which in turn could elaborate the potential causes behind of the phenomenon of productivity paradox?”, the sections 5.1 and 5.2 were revealing about impacts of the experiences in the use of IT, lacking tangible productivity performance monitoring means, and the workplace differences as potential causes of the issue. In respect to the researched potential causes of the productivity paradox, the responses by the knowledge work professionals provided direct and indirect confirmations as well as further information about the origins of the phenomenon. Figure 23 summarizes these findings ranging as dimensions from the macroeconomic level (as introduced in the literature review) all the way to the knowledge worker level (where the work tasks by using IT are carried out) to demonstrate the cumulative influences of each level. The levels include reference information about the relevant sections of this thesis as the sources.

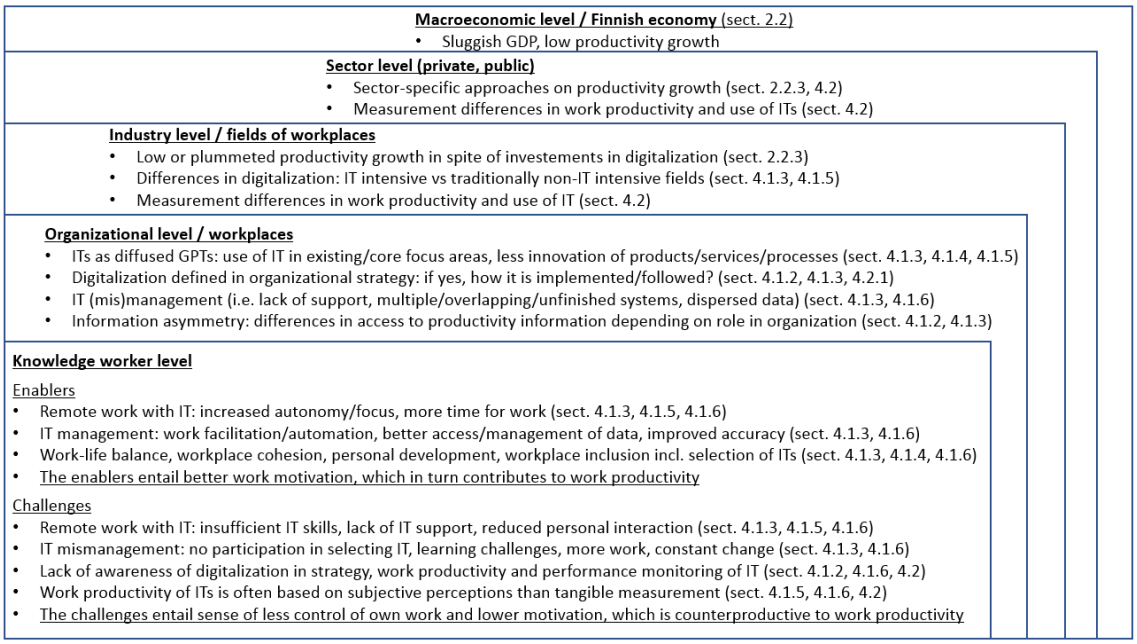

Figure 23. The summary of cumulative contributing impacts of IT on work productivity in different contextual levels (sect. = section(s) for reference).

In particular and as an example, the shift to remote work as a result of social distancing during the COVID-19 pandemic was seen as a contributing factor according to the respondents: on the one hand it, in some workplaces remote work has enabled better management of routine work tasks with increased autonomy, improved efficiency and focus, and it provided more time for work over non-productive work activities like travelling. Other responses indicated that the introduction of IT in remote work has not been coordinated in workplaces, that including the lack of appropriate skills development opportunities for leveraging IT optimally in own work, which has left impression of lack of end-user support by the related workplace organizations. These and similar findings on increasing the use of (often incomplete and overlapping) IT systems raised concern on whether introduction and adoption of IT is supported in the workplaces as required in provision and development of sufficient skills and knowledge: obviously, inability to leverage introduced IT in full as expected certainly delays the materialization of the expected benefits of IT across an organization, that including the lack of improved productivity. Moreover, based on the previous research on the nature of knowledge work and IT and the failure of organizational transformations when all impacting factors are not considered, it can be argued that materialization of the expectations will not be manifested later if the defects during the transformation are not addressed appropriately: after all, in line with Drucker's definition, the productivity of knowledge workers depends on having sufficient skills to take responsibility over personal work and its outputs.

The lack of skills development and training can be considered as part of the broader issue of the mismanagement of IT in workplaces, which is another potential cause of the productivity paradox identified by the previous research. Other related responses of the issue defined inadequate evaluation of new IT systems, lack of effective management of increasing number of the systems, and low involvement of members of workplace organizations (particularly in specialist roles) in IT selection and trial processes. The mismanagement was manifested in the form of related challenges in the use of IT in work, that including increased work and learning efforts, end-user frustration and consequent

lower motivation in work, which in turn have had an effect of reducing work productivity: these definitions are aligned with previous researches on the causes of productivity paradox, and their potential impact on knowledge worker productivity was identified. Individual comments also gave indirect indication that the productivity impact of IT may have been also based on exaggerated expectations: the described commonness of IT (e.g., "IT has been used 'always'") by the respondents suggested that there may be misalignment in understanding in different levels of workplaces about the contributing effect of IT, which the lack of the performance monitoring certainly makes more challenging to verify in one form or another. In line of the previous researches, certain respondents outlined the lack of the performance measurement due to the intangible nature of IT, as outrightly unnecessary or as lacking clear value to customers or management. As the comparison between the public and private organizations made clear, IT is often identified particularly in the public sector based on the cost impact rather than the contribution of tangible productivity outputs based on the performance monitoring.

Finally, the macroeconomic researches have demonstrated that the innovative use of technology has been recognized as the basis of generating productivity growth throughout the modern economic history. In light of the results, the use of IT in innovation in general scored lower than the digitalization of the established work processes involving core and communication activities, which indicates that the innovation potential of IT may not be leveraged in full in all workplaces: the outcomes of IT investments in "proven" best practices may produce benefits in forms of staying in par with competition, reaching out new markets, and producing network effects of unprecedented scale, for instance, but they do not necessarily result in new productivity growth in the way that new innovations in products, services and processes have been found to generate. The overall impression is that IT is adopted and used in Finnish workplaces incrementally to digitize established routine work processes to be aligned with other organizations and to interface people (e.g., customers and business partners) who increasingly adopt ITs like social media. Also, the COVID-19 pandemic has driven the digital transformation in many organizations by introducing remote work to carry on the work processes, hence

contributing further to the incremental development. The challenge of improving productivity is further complicated by the lack of verification means: while the diffusion of ITs as GPTs may provide better alignment, the lack of performance monitoring of ITs particularly in domestic (i.e., non-foreing-owned) workplace organizations prevents acquiring tangible information on their impact on work productivity. Again, the importance of skills development at work is pivotal in leveraging potential of ITs in introducing innovations, that including innovations by knowledge workers as part of management and responsibility of their personal work.

5.4 Implications for workplace organizations

Based on the findings of this research, the topics to be addressed by Finnish workplaces can be summarized as related to the alignment of remote and on-site work, increasing inclusion of all knowledge workers in the adoption and use of IT, and the development of reasonable measurement methods for tangible follow-up of work productivity of IT and in relation to organizational goals to crystallize importance of IT in workplaces.

The alignment of remote and on-site work relates to the fact that in many cases remote work has become the mainstream form of work as a result of the COVID-19 pandemic. As the respondents described, there are pros and cons with the new work mode, which indicates that workplaces would need to find the right balance to ensure that the expected productivity outcomes by dedicated workers can be realized: while majority of respondents indicated (as rather subjective experiences and perceptions) about improved productivity due to remote work, others indicated opposite including potential counterproductive outcomes. Also, certain work continues to require on-site presence in fields such as commerce, healthcare or industrial operators, which cannot be handled remotely. The main theme of concern which emerged from the analyses related to whether IT is effectively managed as part of personal work tasks in different workplaces: this relates also to whether the introduction and adoption of IT are supported in inclusive and empowering ways in the workplaces, which the high number of “I do not know” answers and qualitative analysis of the open-ended responses indicate as not certain.

Also, high number of “No” answers on participation in selecting ITs used as part of personal work (particularly the respondents in specialist roles) indicated about lacking knowledge worker-originated approaches in determining preferred tools and methods: whereas the management may be aware of the optimal IT solutions to be used in work tasks, the perspectives and experiences of knowledge workers in any professional roles should not be ignored, undervalued, or dismissed altogether by default if the outcomes including increased productivity are expected to materialize. Since the work productivity by knowledge workers in line with Drucker’s definitions is highly dependent on introducing means of managing personal work to take effectively responsibility of it including its productivity and further innovation, this places importance on workplace organizations to provide facilitating elements such as learning, teaching and support of the workers; moreover so, as the workers need to be appreciated in modern organizations as a productive asset, which underlines the importance of having appropriate organizational support in adoption and introduction of ITs. Based on the responses on IT skills and training, finding and designing the ways of implementing learning opportunities and for further innovation as part of personal work through practice would be the most applicable paths in most Finnish workplaces, particularly in the public sector but also in the private sector.

As the researches over the previous Industrial Revolutions have founded, innovation by leveraging technology is the most pivotal precondition of improving productivity. Based on the survey results, innovation involving the use of IT in general has not been among top priorities in many Finnish workplaces. Individual responses indicated that personal interaction was important in the provision of a platform for ad hoc encounters involving innovation among workplace colleagues, which underlines the need for considering how beneficial interpersonal dynamics based on the pre-COVID-19 experiences could be maintained or improved to facilitate productive outcomes further. This necessitates evaluation of ways of working and supportive measures like training or education to increase innovation capabilities of knowledge work professionals, while also considering workplace, field or sector specifics to enable the materialization of the outcomes. The main

purpose of such innovation-driven culture is to provide the knowledge workers with effective means of designing, developing and improving personal work, its management and the consequent outputs, and to enable them to share the innovations with others at work for mutual benefit: to enable such contextual platform, workplace organizations need to be the drivers in cultivation of the innovation orientation which takes into account specifics such as the field of workplace, work tasks involved, and skills and knowledge needs by the knowledge workers.

Above all, addressing productivity of IT requires its positioning in respect to organizational goals to make its importance crystallized and effectiveness clear: alinged with the previous researches, the respondents indicated that focus on traditional productivity alone is not meaningful due to the intangible nature of IT, whereas elements such as quality of products or services may be more important in improving productivity. Certain respondents indicated that IT is rather common, obvious and standardized part of work, and which work productivity may not, cannot, or should not be measured. Nevertheless, it can be argued that improving productivity of IT (or any other input of a production process) requires tangible means for the evaluation, which necessitates of having some metrics and measurement practices. The importance of this requirement is underlined by the high number of “I do not know” answers on the productivity of IT to the questions of the survey. After all, the productivity of each knowledge worker depends on being able to manage personal work, which is arguably difficult to analyse without tangible data about the work including the impact of the inputs; and when such analysis is lacking, the work, its management and hence its productivity continue to be based on suboptimal subjective evaluation only. As an additional side effect, more tangible measurement and evaluation means could contribute by improving work motivation as a result of having better tools for managing own work based on the data. Another solid argument for the metrics and measurement of IT is that based on the respondents the cost impact of IT is recognized in most Finnish workplaces (and most likely the costs continue to grow due to remote work becoming mainstream with increasing use of IT), which calls for better means of evaluating the cost-benefit of IT.

Previous researches have identified such measurement as challenging specifically in public sector, partially because the concept of productivity including its measurement practices originate from private sector contexts. In this research, on workplace sector level the challenge of productivity measurement was identified as relevant in the public sector workplaces in particular, where the management appeared to lack awareness on the productivity of introduced IT and focusing on the cost implications only. As defined previously, the number of respondents working in the public sector was relatively small in absolute numbers while representing the sector specific shares of the members according the previous research by the IL. This sector specific fact necessitates further research over the sectors to provide better validity and to improve accuracy of the development requirements for leveraging IT with performance measurement. Moreover on the private sector, the responses by the respondents working in foreign-owned companies indicated that their workplace organizations may have more holistic approaches in applying performance measurement of IT and in respect to the improved productivity of IT: the learnings and best practices by these workplace organizations may be beneficial for non-foreign owned Finnish organizations by introducing applicable measurement methods and other means of analysis for determining the productivity impact of IT with better accuracy and consequent effectiveness.

5.5 Further research

This research study was carried out among knowledge work professionals working in Finnish workplace organizations, and it involved the members of IL (the Union of Professional Engineers in Finland) as the case study focus group where the primary data by using survey strategy was collected. The gathered data was analyzed by using mixed method approach involving quantitative and qualitative methods, which contributed with complementing insights from which the conclusions were derived. The findings can be leveraged as a basis in carrying out more contextually wider or focused research over the topic area: for example, due to the limitations in absolute numbers of answers from certain fields of workplaces as well as the public sector respondents in particular,

additional research on the organizations on impact of the COVID-19 pandemic (e.g., remote work, support in adoption of IT), cost and benefit evaluation in relation to work productivity, and tangible meaning of digitalization as part of organizational strategies would be beneficial, as these topics would contribute further with better focus. Moreover, the established differences by foreign-owned and domestic (Finnish) organizations in determining improved productivity and conducting performance monitoring of IT call for focused study on how these two areas are related, either as sequentially or mutually complementing in case of the two organization types: the potential outcome of the follow-up research could be suggestions on tangible methods and best practices determining productivity of IT in the related workplace organizations. Given the results on IT and innovation, the follow-up on emergence of ITs such as big data and AI, among others, in enabling better means of determining work productivity of IT would need to be considered, since the innovations based on these complementary ITs could have enhanced capabilities to introduce better work productivity as well as means of determining its development in more tangible manner. Finally, the impact of size of organizations and other organizational factors in respect to accessing productivity information requires further research: since work productivity of knowledge workers depends on having sufficient level of autonomy as well as responsibility in carrying out work tasks, the information over own personal (and when interrelated, also others') work productivity is profoundly important in guiding one's activities such as making adjustments based on the information. The reasons behind of the lack of access to such guiding information would need to be researched, since the development of methods for accessing relevant productivity information to enable better management of personal work would cumulatively benefit the organizations of similar scale, field and sector, and, consequently, the total economy.

References

Adamczewski, P. (2016). ICT solutions in intelligent organizations as challenges in a knowledge economy. *Management*, 20(2), 198-209.

Ailisto, H., Hiekkanen, K., Kortelainen, H. & Seppälä, T. (2021a). *Miksi työn tuottavuus ei kasva?* ResearchGate. https://www.researchgate.net/publication/350495646_Miksi_tyon_tuottavuus_ei_kasva

Ailisto, H., Kortelainen, H., Hiekkanen, K. & Seppälä, T. (2021b). *Politiikkasuositus: Kuinka Suomen kävi: lunastiko digitalisaatio siihen asetetut toiveet?* Aalto University. https://www.aalto.fi/sites/g/files/flghsv161/files/2021-01/DDI%20politiikkasuositus%20Kuinka%20Suomen%20kavi.pdf

André, C. & Chalaux, T. (2016). Boosting Productivity in Finland. *OECD Economics Department Working Papers No. 1319.* https://dx.doi.org/10.1787/5jlv23b11mtl-en

Aral, S. (2020). *The Hype Machine: How Social Media Disrupts Our Elections, Our Economy, and Our Health–and How We Must Adapt*. Currency.

Baines, T. & Lightfoot, H. (2013). *Made to serve. How manufacturers can compete through servitization and product-service systems.* John Wiley & Sons. ISBN: 978-1-118-58531-3.

Bank of Finland. (2018). *Työn tuottavuuden heikkouteen monia syitä. Eurojatalous.fi — Suomen Pankin ajankohtaisia artikkeleita taloudesta.* https://www.eurojatalous.fi/fi/2018/5/tyon-tuottavuuden-heikkouteen-monia-syita/

Bouwman, H., Van Den Hooff, B., Van De Wijngaert, L. & Van Dijk, J. (2005). *Information and communication technology in organizations: adoption, implementation, use and effects*. Sage.

Bruun, M. (2014). *Miten mitata julkisen sektorin kokoa.* Tilastokeskus. https://www.stat.fi/tietotrendit/artikkelit/2014/miten-mitata-julkisen-sektorin-kokoa/

Brynjolfsson, E. (1992). The Productivity Paradox of Information Technology: Review and Assessment. Published in *Communications of the ACM*, December, 1993. http://ccs.mit.edu/papers/CCSWP130/ccswp130.html#4i

Buchanan, D. & Huczynski, A. (2019). *Organizational behaviour.* Pearson UK.

Castrén, L., Kauhanen, A., Kulvik, M., Kulvik-Laine, S., Lönnqvist, A., Maijanen, S., Martikainen, O., Palvalin, M., Peltonen, I., Ranta, P., Vuolle, M. & Zhang, Y. (2013). ICT ja palvelut. Näkökulmia Tuottavuuden Kehittämiseen. *Helsinki: Taloustieto Oy. ETLAn julkaisu sarjassa B*, *259*.

Claeys, G., & Demertzis, M. (2021). *The productivity paradox: policy lessons from MICRO-PROD* (No. 2021/01). Bruegel Policy Contribution.

Clausnitzer, J. (2022). *Number of employed people in Finland in 2021, by sector* [Infographic]. Statista. https://www.statista.com/statistics/1167172/finland-employment-by-sector/

CORE (2022). *The Economy. Unit 2. Technology, population, and growth.* Core project. https://www.core-econ.org/the-economy/book/text/02.html

Creswell, J. & Plano Clark, V. (2011). *Designing and conducting mixed methods research.* Sage publications.

Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A. & Sheikh, A. (2011). The case study approach. *BMC medical research methodology*, *11*(1), 1-9.

Davenport, T. H., & Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Harvard Business Press.

David, P. & Wright, G. (1999). General Purpose Technologies and Surges in Productivity. *The Economic Future in Historical Perspective.* https://britishacademy.universitypresss-cholarship.com/view/10.5871/bacad/9780197263471.001.0001/upso-9780197263471

Davis, S. & Meyer, C. (1998). *Blur. The Speed of Change in the Connected Economy.* Addi-son-Wesley.

Dreyfuss, E., Gadson, A., Riding, T. & Wang, A. (2008). *The IT Productivity Paradox.* Stan-ford University. https://cs.stanford.edu/people/eroberts/cs181/projects/productivity-paradox/

Drucker, P. (1999). Knowledge-worker productivity: The biggest challenge. *California management review,* 41(2), pp. 79-94.

Döhring, B., Hristov, A., Maier, C., Roeger, W. & Thum-Thysen, A. (2021). COVID-19 accel-eration in digitalization, aggregate productivity growth and the functional income distri-bution. *International Economics and Economic Policy,* 18(3), pp. 571–604.

Edquist, H. & Henrekson, M. (2006). Technological Breakthroughs and Productivity Growth. *Research Institute of Industrial Economics.* Emerald Group Publishing Limited.

Finnish Productivity Board. (2020). *The State of Productivity in Finland. Why did its growth stop? Will it start again?* Publications of the Ministry of Finance. http://urn.fi/URN:ISBN:978-952-367-291-8

FITech. (2022). *FITech 101: Jatkuvan oppimisen johtaminen. Työn muutos ja oppiminen organisaatioissa* [Online lecture material]. https://mooc.fitech.io/fi/lessons/tyon-muutos-ja-oppiminen-organisaatioissa/

Fornaro, P., Kuosmanen, N., Kuosmanen, T. & Maczulskij, T. (2021). *Labour productivity and reallocation in Finland in 2000-2018.* Prime Minister's Office. http://urn.fi/URN:ISBN:978-952-383-401-9

Foster, K. (2022). *Organization Theory.* Encyclopædia Britannica. https://www.britannica.com/topic/organization-theory

Galanti, T., Guidetti, G., Mazzei, E., Zappalà, S. & Toscano, F. (2021). Work From Home During the COVID-19 Outbreak: The Impact on Employees' Remote Work Productivity, Engagement, and Stress. *Journal of occupational and environmental medicine*, 63(7), 426–432. https://doi.org/10.1097/JOM.0000000000002236

Gebauer, H., Fleisch, E., Lamprecht, C. & Wortmann, F. (2020). Growth paths for overcoming the digitalization paradox. *Business Horizons*, 63(3), pp. 313-323.

Gupta, M. (2020). *What is Digitization, Digitalization, and Digital Transformation?* ARC Advisory Group. https://www.arcweb.com/blog/what-digitization-digitalization-digital-transformation

Harris, D. (Ed.). (1994). *Organizational linkages: Understanding the productivity paradox.* National Academies Press. https://doi.org/10.17226/2135.

Hatch, M. (2018). *Organization Theory. Modern, Symbolic, and Postmodern Perspectives.* Oxford University Press.

IL ry. (2022a). *Information on the Union of Professional Engineers in Finland in a nutshell.* The Union of Professional Engineers in Finland. Retrieved 2022-05-30 from https://www.ilry.fi/en/information-on-the-union-of-professional-engineers/in-a-nutshell/

IL ry. (2021b). *Salary statistics.* The Union of Professional Engineers in Finland [Restricted availability]. Retrieved 2022-09-23 from https://www.ilry.fi/

IL ry. (2022c). *The organization.* The Union of Professional Engineers in Finland. Retrieved 2022-05-30 from https://www.ilry.fi/en/information-on-the-union-of-professional-engineers/the-organization/

Innolytics. (2020). *What is digitalization?* Digitalization - The Complete Guide. Retrieved 2021-09-28 from https://innolytics-innovation.com/what-is-digitalization/

Ipe, M. (2003). Knowledge sharing in organizations: A conceptual framework. *Human resource development review*, 2(4), pp. 337-359.

Kummerow, E. & Kirby, N. (2013). *Organizational culture: Concept, context, and measurement (in two volumes).* World Scientific.

Macdonald, S., Anderson, P. & Kimbel, D. (2000). Measurement or Management? Revisiting the Productivity Paradox of Information Technology. *Vierteljahrshefte zur Wirtschaftsforschung*, 69 (4), pp. 601-617.

Mills, A. J., Durepos, G. & Wiebe, E. (Eds.). (2010). *Encyclopedia of case study research.* Sage Publications.

Muzam, J. (2022). The Challenges of Modern Economy on the Competencies of Knowledge Workers. *Journal of the Knowledge Economy*, pp. 1-37.

Nonaka, I. &Takeuchi, H. (1995). *The knowledge-creating company. How Japanese companies create the dynamics of innovation.* Oxford University Press.

OECD. (2022). *Productivity.* OECD iLibrary. Retrieved 2022-03-29 from https://doi.org/10.1787/0bb009ec-en

Okkonen, J., Vuori, V. & Helander, N. (2018). Enablers and restraints of knowledge work–Implications by certain professions? *Cogent Business & Management*, 5(1), 1504408.

Okkonen, J., Vuori, V. & Palvalin, M. (2019). Digitalization changing work: Employees' view on the benefits and hindrances. In *International Conference on Information Technology & Systems* , pp. 165-176. Springer, Cham.

Parviainen, P., Kääriäinen, J., Honkatukia, J. & Federley, M. (2017). *Julkishallinnon digitalisaatio–tuottavuus ja hyötyjen mittaaminen.* Prime Minister´s Office. http://urn.fi/URN:ISBN:978-952-287-329-3

Pisu, M., Von Rüden, C., Hwang, H. & Nicoletti, G. (2021). Spurring growth and closing gaps through digitalization in a post-COVID world: Policies to LIFT all boats, *OECD Economic Policy Papers*, (30), OECD Publishing, https://doi.org/10.1787/b9622a7a-en.

Pohjola, M. (2020). *Teknologia, investoinnit, rakennemuutos ja tuottavuus: Suomi kansainvälisessä vertailussa.* Ministry of Economic Affairs and Employment. http://urn.fi/URN:ISBN:978-952-327-492-1

Rantanen, H. (2005). *Tuottavuus suorituskyvyn analysoinnin kentässä.* Lappeenrannan teknillinen yliopisto, Lahden yksikkö.

Roth, F. (2022). The Productivity Puzzle. A Critical Assessment and an Outlook on the COVID-19 Crisis. In *Intangible Capital and Growth*, (pp. 1-16). Contributions to Economics. Springer, Cham. https://doi.org/10.1007/978-3-030-86186-5_1

Saunders, M., Lewis, P. & Thornhill, A. (2019). *Research Methods for Business Students.* Pearson education.

Savela, O. (2010). Palvelujen tuottavuutta ei aina kannata parantaa. *Hyvinvointikatsaus*, 2.

Schallmo, D. & Tidd, J. (Eds.) (2021). *Digitalization. Approaches, Case Studies, and Tools for Strategy, Transformation and Implementation*. Springer Cham. https://doi.org/10.1007/978-3-030-69380-0

Schumpeter. (2015). *Digital Taylorism.* The Economist. https://www.economist.com/business/2015/09/10/digital-taylorism

Schwab, K. (2022). *The Fourth Industrial Revolution*. Encyclopædia Britannica. https://www.britannica.com/topic/The-Fourth-Industrial-Revolution-2119734

Schweikl, S. & Obermaier, R. (2020). Lessons from three decades of IT productivity research: towards a better understanding of IT-induced productivity effects. *Management Review Quarterly*, 70(4), pp. 461–507. https://doi.org/10.1007/s11301-019-00173-6

Shujahat, M., Sousa, M. J., Hussain, S., Nawaz, F., Wang, M. & Umer, M. (2019). Translating the impact of knowledge management processes into knowledge-based innovation:

The neglected and mediating role of knowledge-worker productivity. *Journal of Business Research*, 94, pp. 442-450.

Statista. (2020). *COVID-19 measures and their effects on mobility behaviour. Statista DossierPlus on the fight against the spread of COVID-19 and its effects on mobility* [Report]. 41 pages.

Stenborg, M., Huovari, J., Kiema, I., Elmgren, P. & Maliranta, M. (2021). *Productivity and resource allocation–Weak level and growth of productivity in Finland's digital services.* Ministry of Finance. http://urn.fi/URN:ISBN:978-952-367-909-2

Syverson, C. (2011). What determines productivity?. *Journal of Economic Literature*, 49(2), pp. 326-65.

Tardieu, H., Daly, D., Esteban-Lauzán, J., Hall, J. & Miller, G. (2020). *Deliberately Digital.* Springer Cham. https://doi.org/10.1007/978-3-030-37955-1

Tuomi, I. (2004). Economic productivity in the Knowledge Society: A critical review of productivity theory and the impacts of ICT. *First Monday*, 9(7).

Uusi-Rauva, E. (toim.) (1997) *Tuottavuus – mittaa ja menesty.* Kauppakaari Oy.

Valtioneuvosto. (2021). *Parlamentaarisen TKI-työryhmän loppuraportti.* http://urn.fi/URN:ISBN:978-952-383-516-0

van Ark, B. (2016). The Productivity Paradox of the New Digital Economy. *International Productivity Monitor*, 31, pp. 3-18.

van Ark, B., De Vries, K. & Erumban, A. (2021). How to not miss a productivity revival once again. *National Institute Economic Review*, 255, pp. 9-24. https://doi.org/10.1017/nie.2020.49

Vuori, V., Helander, N. & Okkonen, J. (2019). Digitalization in knowledge work: the dream of enhanced performance. *Cognition, Technology & Work*, 21(2), pp. 237-252.

Vähämäki, M., Kuusi, T., Laiho, M. & Kulvik, M. (2019). The Road to Productivity With Automatization: Dialogue Between the Experienced and Measured. In *Digital Work and the Platform Economy*, pp. 116-141. Routledge.

WHO. (2022). *WHO Coronavirus (COVID-19) Dashboard*. World Health Organization [Webpage]. Retrieved 2022-05-30 from https://covid19.who.int/

Yin, R. (2009). *Case Study Research: Design and Methods*. Sage Publications.

Appendices

Appendix 1. Demographics of the questionnaire respondents

Age (in years)

	n	Percent
18-35	52	15,8 %
36-50	139	42,1 %
51-60	104	31,5 %
over 61	35	10,6 %

Gender

	n	Percent
female	62	18,8 %
male	262	79,4 %
other	1	0,3 %
I do not want to answer	5	1,5 %

Residence, 1/2: Which province do you live in?

	n	Percent
Ahvenanmaa	0	0,0 %
Etelä-Karjala	7	2,1 %
Etelä-Pohjanmaa	10	3,0 %
Etelä-Savo	7	2,1 %
Kainuu	5	1,5 %
Kanta-Häme	11	3,3 %
Keski-Pohjanmaa	1	0,3 %
Keski-Suomi	22	6,7 %
Kymenlaakso	9	2,7 %
Lappi	9	2,7 %
Pirkanmaa	38	11,5 %
Pohjanmaa	16	4,9 %
Pohjois-Karjala	7	2,1 %
Pohjois-Pohjanmaa	30	9,1 %
Pohjois-Savo	13	4,0 %
Päijät-Häme	10	3,0 %
Satakunta	14	4,3 %
Uusimaa	94	28,5 %
Varsinais-Suomi	27	8,2 %

Residence, 2/2: Do you live in...

	n	Percent
a sparsely populated area?	64	19,4 %
a city?	214	64,8 %
a small locality	50	15,2 %
somewhere else, where?	2	0,6 %

Your latest degree?

	n	Percent
Bachelor of Engineering (Polytechnic degree)	209	63,3 %
Other polytechnic degree, what area and level?	31	9,4 %
University degree (f.ex. M.Sc., MBA), what?	34	10,3 %
Vocational degree (f.ex. Vocational Qualification in IT), what?	38	11,5 %
Other, what?	18	5,5 %

Your work experience...

	less than 1 year	1-2 years	3-5 years	6-10 years	11-20 years	over 20 years	To-tal
after latest graduation	9	15	28	31	68	163	314
	2,9 %	4,8 %	8,9 %	9,9 %	21,6 %	51,9 %	
in current employment	34	34	65	44	49	82	308
	11,1 %	11,0 %	21,1 %	14,3 %	15,9 %	26,6 %	
in total	1	2	12	27	62	180	284
	0,4 %	0,7 %	4,2 %	9,5 %	21,8 %	63,4 %	

Which of the following describes your current employment status?

	n	Percent
Top management (f.ex. CEO or chief general manager)	5	1,5 %
Upper middle management (f.ex. unit, office, purchasing, or sales manager)	46	14,1 %
Lower middle management (f.ex. independent management role, team management, supervisor)	50	15,3 %
Expert role (f.ex. design, R&D, other expert role including teaching)	197	60,3 %
Office holder (f.ex. non-independent role, sales, office work, secretary or assistant)	21	6,4 %
Entrepreneur or other independent role/position	2	0,6 %
Other role or position, what?	6	1,8 %

Appendix 2. The results of the crosstabulated responses on the questions on productivity of introduced IT/methods and performance monitoring in respect to workplace fields

IDK = I do not know

Increased productivity? = Has introduction of IT increased work productivity in your workplace?

Perf. monitoring? = Does your workplace monitor performance of IT and/or methods?

5	most answers in absolute numbers
4	second most answers in absolute numbers
8	most total "IDK" answers in absolute numbers on increased productivity
8	most total "Yes" answers in absolute numbers on increased productivity

Industrial operator		*Perf. monitoring?* Yes	No	IDK	Total
Increased productivity?	Yes	16	12	21	49
		66,7 %	60,0 %	29,6 %	42,6 %
	No	0	4	6	10
		0,0 %	20,0 %	8,5 %	8,7 %
	IDK	8	4	44	56
		33,3 %	20,0 %	62,0 %	48,7 %
Total		24	20	71	115
		100 %	100 %	100 %	100 %

IT based services or game industry		*Perf. monitoring?* Yes	No	IDK	Total
Increased productivity?	Yes	15	3	5	23
		65,2 %	33,3 %	15,2 %	35,4 %
	No	1	4	2	7
		4,3 %	44,4 %	6,1 %	10,8 %
	IDK	7	2	26	35
		30,4 %	22,2 %	78,8 %	53,8 %
Total		23	9	33	65
		100 %	100 %	100 %	100 %

Engineering/ design/ consultancy		*Perf. monitoring?* Yes	No	IDK	Total
Increased productivity?	Yes	7	6	9	22
		100 %	60,0 %	24,3 %	40,7 %
	No	0	4	4	8
		0,0 %	40,0 %	10,8 %	14,8 %
	IDK	0	0	24	24
		0,0 %	0,0 %	64,9 %	44,4 %
Total		7	10	37	54
		100 %	100 %	100 %	100 %

Commerce or other service sector		*Perf. monitoring?* Yes	No	IDK	Total
Increased productivity?	Yes	1	4	3	8
		50,0 %	57,1 %	60,0 %	57,1 %
	No	1	3	0	4
		50,0 %	42,9 %	0,0 %	28,6 %
	IDK	0	0	2	2
		0,0 %	0,0 %	40,0 %	14,3 %
Total		2	7	5	14
		100 %	100 %	100 %	100 %

IDK = I do not know

Increased productivity? = Has introduction of IT increased work productivity in your workplace?

Perf. monitoring? = Does your workplace monitor performance of IT and/or methods?

5	most answers in absolute numbers
4	second most answers in absolute numbers
8	most total "IDK" answers in absolute numbers on increased productivity
8	most total "Yes" answers in absolute numbers on increased productivity

Municipality/ association of/government		*Perf. monitoring?* Yes	No	IDK	Total
Increa-sed producti-vity?	Yes	1	1	1	3
		33,3 %	25,0 %	7,7 %	15,0 %
	No	0	2	0	2
		0,0 %	50,0 %	0,0 %	10,0 %
	IDK	2	1	12	15
		66,7 %	25,0 %	92,3 %	75,0 %
Total		3	4	13	20
		100 %	100 %	100 %	100 %

Other in public sector		*Perf. monitoring?* Yes	No	IDK	Total
Increased producti-vity?	Yes	2	3	3	8
		100 %	75,0 %	23,1 %	42,1 %
	No				
	IDK	0	1	10	11
		0,0 %	25,0 %	76,9 %	57,9 %
Total		2	4	13	19
		100 %	100 %	100 %	100 %

Other in private sector		*Perf. monitoring?* Yes	No	IDK	Total
Increased productivity?	Yes	2	1	4	7
		100 %	25,0 %	40,0 %	43,8 %
	No	0	0	1	1
		0,0 %	0,0 %	10,0 %	6,3 %
	IDK	0	3	5	8
		0,0 %	75,0 %	50,0 %	50,0 %
Total		2	4	10	16
		100 %	100 %	100 %	100 %

Healthcare		*Perf. monitoring?* Yes	No	IDK	Total
Increased producti-vity?	Yes	1		0	1
		100 %		0,0 %	33,3 %
	IDK	0		2	2
		0,0 %		100 %	66,7 %
Total		1		2	3
		100 %		100 %	100 %

Appendix 3. Questionnaire sent to the IL members for collecting primary data

Utilisation of Information Technology in Workplace

Dear recipient,

during past decades, products, services and processes have been digitalised to improve work productivity, among others. Better productivity by leveraging information technology (IT) has been outlined as precondition to achieve goals of welfare and economic growth. Despite of investments in digitalisation, achieving productivity expetations has varied.

Welcome to survey about utilisation of information technology in workplace!
The purpose is to clarify importance of IT in respect to work productivity, and to identify benefits and challenges involved.

Thank you for the cooperation!

1. Your current status: I am *

- ◯ employed
- ◯ a student
- ◯ retired
- ◯ unemployed

Your Background Information

2. Age (in years) *

- ◯ 18-35
- ◯ 36-50
- ◯ 51-60
- ◯ over 61

3. Gender *

- ◯ female
- ◯ male
- ◯ other

- ◯ I do not want to answer

4. Residence, 1/2: Which province do you live in? *

- ◯ Ahvenanmaa
- ◯ Etelä-Karjala
- ◯ Etelä-Pohjanmaa
- ◯ Etelä-Savo
- ◯ Kainuu
- ◯ Kanta-Häme
- ◯ Keski-Pohjanmaa
- ◯ Keski-Suomi
- ◯ Kymenlaakso
- ◯ Lappi
- ◯ Pirkanmaa
- ◯ Pohjanmaa
- ◯ Pohjois-Karjala
- ◯ Pohjois-Pohjanmaa
- ◯ Pohjois-Savo
- ◯ Päijät-Häme
- ◯ Satakunta
- ◯ Uusimaa
- ◯ Varsinais-Suomi

5. Residence, 2/2: Do you live in... *

- ◯ a sparsely populated area?
- ◯ a city?
- ◯ a small locality
- ◯ somewhere else, where? _____

6. Your latest degree? *

- ◯ Bachelor of Engineering (Polytechnic degree)
- ◯ Other polytechnic degree, what area and level? _____
- ◯ University degree (f.ex. M.Sc., MBA), what? _____
- ◯ Vocational degree (f.ex. Vocational Qualification in IT), what? _____
- ◯ Other, what? _____

7. Your work experience...

	less than 1 year	1-2 years	3-5 years	6-10 years	11-20 years	over 20 years
after latest graduation	◯	◯	◯	◯	◯	◯
in current employment	◯	◯	◯	◯	◯	◯
in total	◯	◯	◯	◯	◯	◯

8. Which of the following describes your current employment status?

- ◯ Top management (f.ex. CEO or chief general manager)
- ◯ Upper middle management (f.ex. unit, office, purchasing, or sales manager)
- ◯ Lower middle management (f.ex. independent management role, team management, supervisor)
- ◯ Expert role (f.ex. design, R&D, other expert role including teaching)
- ◯ Office-holder (f.ex. non-independent role, sales, office work, secretary or assistant)
- ◯ Entrepreneur or other independent role/position
- ◯ Other role or position, what? _____

Workplace Background Information

9. Which of the following describes the field of your current workplace?

- ◯ Industrial operator (domestic or foreign market)

- ◯ Engineering, design, or consultancy agency
- ◯ IT-based services or game industry
- ◯ Commerce or other service sector
- ◯ Healthcare
- ◯ Municipality, association of municipalities or state
- ◯ Other in public sector, what? _____
- ◯ Other in private sector, what? _____

10. How many people are employed in your workplace in Finland?

- ◯ 1-29
- ◯ 30-99
- ◯ 100-499
- ◯ 500-999
- ◯ over 1000

11. Is your workplace a foreign-owned (over 50%) company?

- ◯ Yes
- ◯ No

12. Has your workplace outlined digitalisation in organisational strategy?

- ◯ Yes
- ◯ No
- ◯ I do not know

Utilisation of Information Technology in Workplace

13. According to my workplace strategy, digitalisation aims to ...

- [ ] reach out new markets and/or customer segments
- [ ] improve current productivity
- [ ] maintain current level of productivity
- [ ] staying in the competition
- [ ] regulatory compliance, what exactly? _____
- [ ] something else, what? _____

14. Which form of IT is used or may be used in future in your workplace?

	no information	potential identified, not in use	potential identified, likely to be used	used 1-2 years	used over 2 years
3D printing	○	○	○	○	○
Artificial intelligence (AI)	○	○	○	○	○
Big data	○	○	○	○	○
Blockchain	○	○	○	○	○
Cloud computing	○	○	○	○	○
Industrial Internet	○	○	○	○	○
Internet of Things (IoT)	○	○	○	○	○
Robotic process automation	○	○	○	○	○
Social media	○	○	○	○	○
Virtualisation	○	○	○	○	○
Wireless data transfer technologies (f.ex. 5G)	○	○	○	○	○
Something else, what? _____	○	○	○	○	○
	○	○	○	○	○

15. What IT-related work methods are used or may be used in future in your workplace?

	no information	potential identified,	potential identified,	used 1-2	used over

		not in use	likely to be used	years	2 years
Agile	◯	◯	◯	◯	◯
Just-in-Time/Kaizen	◯	◯	◯	◯	◯
Lean	◯	◯	◯	◯	◯
Three View Point Model (3VPM) methodology	◯	◯	◯	◯	◯
Bricolage methodology	◯	◯	◯	◯	◯
Ad hoc innovation methodology	◯	◯	◯	◯	◯
Service design	◯	◯	◯	◯	◯
Human-machine interaction	◯	◯	◯	◯	◯
Something else, what? _____	◯	◯	◯	◯	◯

16. Have you participated (e.g. surveys) in choosing IT or methods related to your work?

◯ Yes

◯ No

17. What activities have been digitalised with IT in your workplace during 2-5 years?

- [ ] Development of core products / services / processes
- [ ] Product / service / process innovation (non-core existing/past)
- [ ] Internal communication (e.g. strategy, team communication)
- [ ] External communication (e.g. media relations)
- [ ] Maintenance and monitoring of nuclear or other activities
- [ ] Customer sales
- [ ] Sales (B2C, B2B, e-commerce)
- [ ] Financial management
- [ ] Cooperation between organisations
- [ ] Other field(s), what? _____

18. Due to introduction of IT and / or methods in my current workplace,...

	completely true	to some extent true	not true at all	I do not know
processes have become more efficient	○	○	○	○
new processes have replaced old ones	○	○	○	○
my use of time has become more efficient	○	○	○	○
working remotely is now possible	○	○	○	○
my skills have improved	○	○	○	○
access to information has improved	○	○	○	○
external communication (e.g. with customers) is faster or smoother	○	○	○	○
internal communication (e.g. with colleagues) is faster or smoother	○	○	○	○
my work motivation is better than before	○	○	○	○
my workload has increased or my work has become more difficult than before	○	○	○	○
new job positions and people with new skills have been introduced	○	○	○	○

19. Has introduction of IT and/or work methods changed working in some other way?

IT Skills and Training Opportunities

20. How much time you spent developing IT skills during the past year?

Total hours spent at work	
Total hours spent off-work	

21. How do you develop your IT skills in your workplace?

- [ ] Training opportunities, for example _____
- [ ] Learning through practice, for example _____
- [ ] In some other way, for example _____

22. At my workplace, IT skills are needed or applied in...

	completely true	to some extent true	not true at all	I do not know
core product / service development	○	○	○	○
product / service / process innovation (non-core)	○	○	○	○
internal communication (e.g. teamwork)	○	○	○	○
external communication (e.g. media relations)	○	○	○	○
customer service	○	○	○	○
cooperation between organisations	○	○	○	○
searching information	○	○	○	○
maintaining expertise	○	○	○	○
some other activity/activities, such as _____	○	○	○	○

23. At my workplace, IT skills are acquired by/via...

- [ ] training personnel
- [ ] recruiting skilled personnel
- [ ] cooperation between organisations (e.g. transfer or exchange of knowledge or skills)
- [ ] mergers and acquisitions of other organisations
- [ ] establishing subsidiaries geographically closer to skilled experts
- [ ] some other way, for example _____

IT in Workplace during COVID-19

24. During COVID-19, at my workplace...

- [ ] IT rollout projects have been re-prioritised, for example _____
- [ ] new IT rollout projects have been started
- [ ] existing IT has been more widely adopted or it's use encouraged (e.g. innovation, communication)
- [ ] personnel's IT competences have been developed or development encouraged
- [ ] IT has been impacted in some other way, for example _____

25. Use of IT during COVID-19 has (not) improved work productivity because...

Work Productivity of IT in Workplace

26. Does your workplace monitor performance (e.g. indicators) of IT and/or methods?

- ◯ Yes, for example _____
- ◯ No, because _____
- ◯ I do not know

27. Has introduction of IT and/or methods increased work productivity in your workplace?

- ◯ Yes, for example _____
- ◯ No, because _____
- ◯ I do not know

28. Has introduction of IT and/or methods increased costs in your workplace?

- ◯ Yes, for example
- ◯ No
- ◯ I do not know

29. What other factors have influenced development of your work productivity?